JULY • 1956

NLGI Spokesman

Journal of National Lubricating Grease Institute

NLGI SYMPOSIUM—Conclusion Pages 10-29

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President's page

by W. M. MURRAY, President, NLGI

MOMENTUM

Some of us have studied the National Petroleum News forecast in the mid-May issue "Factbook." It is worth reading and offers a valuable reference tool. Although there are practically no data on lubricating greases, the forecast is for the next ten years to be of good business for the oil industry.

I believe that lubricating greases will follow the anticipated general improvement expressed "up 47% by 1966." Lubricating oil increase, while substantial, is expected to be smaller because some of its possible gains due to increased vehicle count will be offset by fewer consumed quarts per unit. Industrial gains should be large. I think that grease reducing devices and methods need not be nearly so volume restricting as those elements affecting motor oils.

Lubricating grease doesn't sell itself—its qualifications for superior and safe lubrication do make the job easier for us. To expand usage and to maintain ratio we must work as an industry at selling and application as well as we work in research and production. NLGI is in working clothes at all times. Visible progress lies in the Institute's SPOKESMAN and in film, program, technical and membership benefit planning.

Tom Miller has tabulated replies to the recent SPOKESMAN questionnaire—33% responded with recommendations and comments. Our readers show greatest interest in technical information, closely followed by new products and patents articles. And here's the good news for sales, the revenue producers — most of the readers favor marketing articles. My old colleague Dayton P. Clark, present chairman of the committee responsible for marketing items is known for successful effort. The future for marketing features is most promising. Pass along more ammunition.

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Published monthly by
National Lubricating Grease Institute
Tom Miller, *Editor*
Joan Swarthout, *Assistant Editor*
4638 J. C. Nichols Parkway
Kansas City 12, Mo.
1 Year Subscription $2.50
1 Year Subscription (Foreign) ..$3.25

NLGI Spokesman

Vol. XX JULY, 1956 No. 4

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ABOUT THE COVER

SUMMERTIME—the nation looks to vacation travel . . . and this summer promises an increase in vacation motorists far outnumbering any previous year. Recent surveys show the trend in this summer's travel fleet moving in staggering numbers away from scenic drives and mountainous routes to the wide and speedy express highways—the fastest way to their destination. Last October NLGI'S annual meeting kickoff speaker, Major General F. D. Merrill, stated that "the cost of good highways is less than the penalty for not having them . . . extreme high costs of our present inadequacies are staggering." See page 9 for more about the continuous progress being made in the direction of the General's plea, "The U. S. Needs Highways for Survival."

THE GENERAL'S DREAM IS BEING REALIZED!

Photo courtesy of Asphalt Institute

U. S. Highways Will Grow, as Former NLGI Keynote Speaker Predicted

IN THE NEXT thirteen years about 50 billion dollars will be spent on highways—General Merrill's dream is being realized.

The late Major General Frank D. Merrill stated the need for more and better roads to NLGI'ers last fall, when he was the keynote speaker at the Institute's 23rd Annual Meeting in Chicago. "The United States Needs Highways for Survival" was the retired army officer's title and text—as commissioner of highways and public works in New Hampshire, General Merrill worked long and hard for increased road construction until his death in January, this year.

The late Major General Frank D. Merrill

Now, the recently passed Federal Highway Act of 1956 will mean the eventual construction of a network of superhighways connecting the larger cities of the U. S., over a network covering some 40,000 miles—nine of these superhighways will run north and south, four more will go across the country. By the late 1960's, the program should be largely completed.

Because of the millions of automobiles now on the streets and in view of prospective units in still more millions to come, vehicle population will increase and the number of miles traveled will grow. But a growing highway system will boost the economy, and projected figures for a gross national product of 535 billion by 1965 may be realized. "The traffic counters the highway engineer places on the highway are an accurate index not only of traffic but prosperity," said General Merrill to the assembly of NLGI members last October.

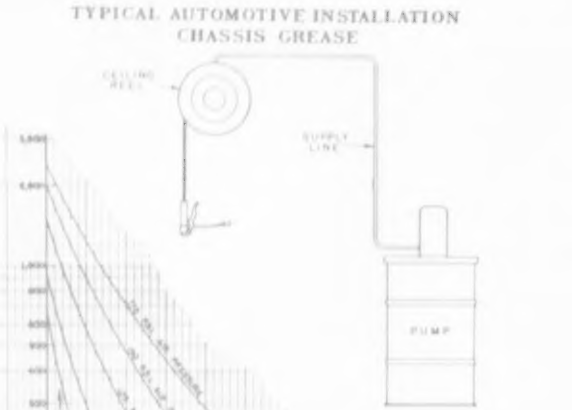
It will be several years before motorists can see much change in highways, but in ten years from now most of the superhighways the General spoke for will be in use for private and public transportation.

NLGI SYMPOSIUM

III—Practical Application of Rheological Constants

Equipment Aspects in Dispensing Grease

By L. C. ROTTER
Lincoln Engineering Company
St. Louis, Missouri



A Dream

IN THE EARLY DAYS of the Lubrication Industry, our main objective, as manufacturers of lubricating equipment, was to produce a pump that would pump—just that and nothing more. Back then, even as today, our main purpose was to please the customer, although in those days we didn't have present day problems. The lubricant was lighter and the equipment was portable. No piping problems encountered.

We still strive to please our customers. But they, like us, realize the Lubrication Industry has not been at a standstill. New and better lubricants have been developed and we constantly endeavor to improve our equipment to keep pace with these developments and customer requirements.

Our methods of approach today are more precise than formerly. For one thing, we value a close association with lubricant manufacturers so that our respective lines of endeavor will not be at cross purposes. Another reason being to keep up-to-date on performance characteristics of our products. We believe in the old saying—"One test is worth a thousand expert opinions." Today, equipment is tested and a practical prediction can be made just how well it will perform.

By laboratory tests, graphs have been developed relating equipment output with oil viscosity. These charts, based on various pumping equipment and several typical installations, make it possible to predict the amount of oil dispensed. The average service station includes approximately 30 feet of ⅜" O.D. tubing and 20 feet of ½" I.D. hose. These charts permit making a fair estimate of what output can be expected from industrial installations where lengths and diameter of supply lines vary.

Viscosity Eliminates Some Problems

The use of viscosity eliminates the temperature problem many times encountered. Charts are available that give viscosity of S.A.E. Grades at various temperatures. All that is necessary is to have the viscosity of the oil at the temperature being pumped.

This is history, and in many cases has been of value. Right now our thinking is toward devising a scheme for greases which will perform for all practical purposes as well as the Oil Viscosity-Output Charts have done.

But there are no S.A.E. numbers for grease. We recall, only too well, our attempts to make sense out of the terms "soft," "medium" and "heavy" as applied to greases. We found, even within our own organization, that no two individuals are in exact agreement as to what constitutes, say, a "medium" grease.

Naturally, this type of confusion led to occasional misapplications. But, what is more important, this lack of meaningful terms has led to misunderstanding. The NLGI tentative method of testing pumpability is limited to the range of minimum output requirement of 2 oz. of grease per minute. This is a step forward, but what about the other many requirements in the market we service?

A common language for greases, such as we have for oils, S.A.E. numbers and viscosity, could be the answer.

Equipment manufacturers know lubricating equipment—and, incidentally, are equipped to test dispensing equipment, but not lubricants—but the field of rheological development is just a little out of our range of activities.

We do endeavor to keep tab on developments. When worked penetration tests were established and NLGI Grades assigned, we endeavored to find a pattern for matching the greases to the pumps. The results were disappointing. It didn't take us long to find out that a pump is not a Penetrometer. It may surprise you as much as it did us to know that a No. 2 grease sometimes pumps better than a No. 1 grease. Even worse than that is the effect of temperature, for the NLGI grade number just does not forewarn that one grease may change consistency very little with temperature while another will change severely.

All of this was quite discouraging, but we had to continue to see what could be done from a practical angle when greases were dispensed. Grease is the only practical lubricant in many cases. Around this time Centralized Lubrication began to mushroom. The benefits of Centralized Lubrication both for Automotive and Industrial use are manyfold, but there are just a lot of installations of Centralized Lubrication where greases are the desirable lubricants.

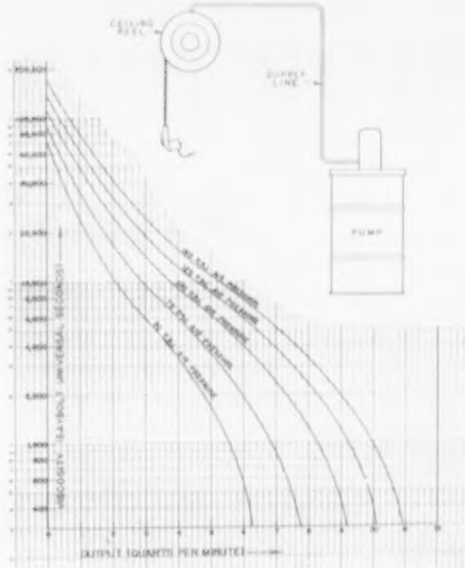
Attempt to Develop Tester

We are not experts in flow properties, but even so we decided to try to develop a test, and perhaps a testing instrument, that would predict grease performance in Centralized Systems. In a Centralized System we have problems of the grease, time, diameter and length of supply lines, and measuring units that are involved. Our reasoning was along these lines: Since the pump pushes grease through a certain length of piping and squirts it out an orifice, why not build a rig that would do the same thing?—plug a gage in it and go by the gage reading under fixed set circumstances. We now realize that we were tinkering with the principle of the pressure viscometer, although we didn't know it at the time. Incidentally, a lubricating pump is merely a form of pressure viscometer, or vice versa; perhaps that is why our instrument was, in its own way, a success.

After a lot of trial and error work, we came up with this gadget. A 25 foot coil of copper tubing with a valve and a grease fitting on one end—try to picture this in your mind, if you will—a valve and a grease fitting on one end, and a valve and gage on the other end. The tubing is charged with grease to be tested until the gage reads 1800 pounds. With valve open, grease can be pushed through the tubing, eliminating any entrapped air. Pressure to be built up after closing valve on outlet end. With pressure reading of 1800 pounds on gage, valve at opposite end of tubing is opened quickly and the grease allowed to vent for half a minute, timed by a stopwatch. The gage reading at the end of the half minute is what we go by.

You can see that it is a very simple tester, but we make no apologies for it. No doubt it is a scientific instrument of a sort. Perhaps it even has a fancy mathematical equation which precisely describes its behavior; but happily it does give us a good idea of just what a grease will do in a Centralized System. It is not perfect: for one thing the reproducability is poor. But when we began having the same operator run all tests, the reproducability improved. No doubt the human element, along with experience, is important in its use.

TYPICAL AUTOMOTIVE INSTALLATION
OIL & GEAR OIL



Along with the instrument readings, we have a chart which ties in with the meter reading, specifying the length of supply lines permissible of a certain size. We made comparison with actual installations. The test must be made at the temperature of the proposed installation. We use a walk-in cooler for running our tests and are able to obtain a temperature range of from close to zero up to room temperature.

If a customer comes to us with a certain grease and wants to know if it will be OK to use this grease in one of our systems he has in his plant, all we have to do is run a test and compare the reading with our chart, and we can give a definite "yes" or "no" answer. We must know diameter and length of supply lines in installation involved. This likewise permits us to determine if certain greases will work in proposed installations; in fact it permits us to recommend proper supply line sizes, thus permitting use of grease that has been recommended. It is practical and has saved us many difficulties, and still requires only 1 pound of grease to get a "yes" or "no" answer.

We are not satisfied. This tool does not have the flexibility and precision of our oil viscosity-output charts. Now that apparent viscosity has come into the picture, we have great hopes for this property as being the common language for the entire lubrication field that we have been seeking. We believe that knowing the apparent viscosity of a grease at the temperature that it will be used will eliminate many problems now encountered. But the very newness of the apparent viscosity concept is one of its biggest drawbacks. We ask ourselves, "How long will it be before this common language is used in the Industry and is understood as viscosity is when pertaining to oil?" The NLGI work on the "tentative method" on pumpability is a step in the right direction and we, as equipment manufacturers, hope that NLGI will follow up on missionary work in making apparent viscosity known, accepted, and appreciated by the lubrication industry.

PREDICTING PRESSURE DROPS

In Grease Distribution Equipment

By E. F. KOENIG—E. M. JOHNSON—E. A. BANIAK

The Texas Company, Beacon, New York

INTRODUCTION

Since the introduction of centralized lubrication systems for grease lubrication of industrial machinery more than twenty years ago, the problem has arisen many times as to the proper grease consistency and the diameter tubing necessary for most satisfactory operation of these systems at a particular temperature and flow rate. Even though the importance of centralized systems to industry has been realized, very little experimental work has been done to determine their optimum performance.

In the past two decades, centralized lubrication systems have become one of the most important pieces of auxiliary equipment in large machinery installations, particularly in steel mills where there are a large number of moving parts which require a specified amount of lubricant at frequent intervals. As an aid to safety, centralized lubrication systems provide lubrication automatically to high or dangerous places, to nearly inaccessible points near moving parts, and to machinery in locations where atmospheric conditions are unhealthy. Thus, lubrication personnel are spared a tremendous amount of risk to injury. Also, centralized systems eliminate the possibility of certain points in isolated locations being overlooked, and also prevent harmful overlubrication.

At the present time, centralized lubrication systems are used almost universally in industry. However, very little experimental work has been done to determine optimum system operation. If the pressure drop through various lines and fittings could be determined at various temperatures and flow rates, then a suitable lubricant could be selected to meet the requirements of a particular set of conditions, i.e., temperature and flow rate. To conduct such large scale pumping tests at various conditions for each lubricant is a time-consuming and expensive proposition. It would, therefore, be very valuable if some standard laboratory apparatus that would correlate with the pumping test could be used. Since the pressure viscosimeter measures apparent viscosity and is very similar in principle of operation to a centralized lubrication system, it was selected to investigate the possibility of a correlation between it and centralized lubrication system operation. The results obtained from this investigation were quite fruitful in terms of nomographic correlation and are presented herewith.

Before entering a discussion of the work however, a brief discussion of viscosity is in order. Viscosity may be defined as that property of a fluid which causes resistance to flow or internal friction. The viscosity coefficient of a fluid may be defined as the ratio between the shearing

stress acting on a unit volume within the fluid and the corresponding rate of shear. When the value of this ratio changes with the shearing stress, the fluid is described as showing non-Newtonian flow. Greases are known to be non-Newtonian and, since their viscosity changes with the rate of shear, they possess no true viscosity coefficient. For materials which behave in this manner, the term "apparent viscosity," N, is now generally applied to the ratio of the shear stress to the rate of shear.

This characteristic of a grease, apparent viscosity, can be readily obtained by use of a pressure viscosimeter

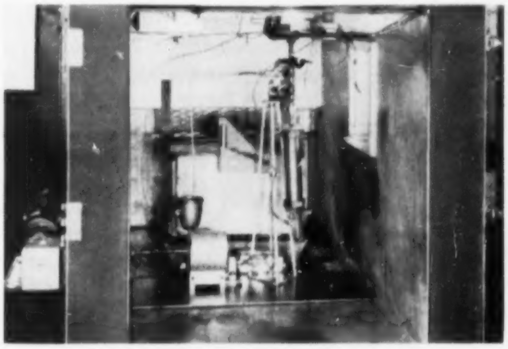


Figure 1. Pressure Viscosimeter Apparatus.

which is standard equipment in many laboratories and is relatively inexpensive to operate.

EXPERIMENTAL WORK

A. Apparatus

1. *Pressure Viscosimeter*

The pressure viscosimeter apparatus which was used to determine the apparent viscosity of the test greases at various shear rates and temperatures is shown in Figure 1. The entire apparatus was enclosed in an insulated box whose inside air temperature could be closely controlled at any desired level between —100°F. and +125°F. The drive motor and speed reducer, A, were connected to the hydraulic oil pump, B, which was fed from the oil reservoir, C. With the pressure relief valve, E, closed, the pump supplied hydraulic pressure to the upper side of a piston in the cylinder, F, which in turn forced the grease below the piston in the cylinder, through the capillary, H. The grease temperature was measured by a thermocouple, G. Additional capillaries of various shear rates are shown in the rack, D.

2. *Centralized Lubrication System*

A mock setup of a centralized lubrication system used in this work is shown in Figure 2. The grease cylinder, A, is shown connected to 25 feet of ½ inch diameter copper tubing. The pressure gage, B, recorded the pressure of the grease just as it left the cylinder. The grease was caught in the container, C, and the flow duration was timed with a stop watch to determine the flow rate. The pump, not shown in Figure 2, which supplied the hydraulic pressure to the grease cylinder was driven by a variable speed transmission, which in turn was connected to a 1725 RPM, 1/3 horsepower motor.

To obtain representative coverage of tubing sizes, lengths and fittings, ¼, ⅜ and ½ inch copper tubing of 50, 25 and 5 foot lengths were used in this work as well as 5 foot lengths with 3 ells and 5 foot lengths with 3 tees. Also, with the ¼ inch tubing a Trabon header block was tested.

B. Procedure

For tests in the mock centralized lubrication system, the greases were pumped through the various lengths of ¼, ⅜ and ½ inch copper tubing at 77°, 50° and 32°F. To keep the time required as low as possible, some of the greases were pumped at only one temperature through one set of copper tubing. However, the greases which were not pumped at all temperatures were pumped at specific temperatures and through specific sets of tubing chosen to give over all representative results for the group of greases tested. Also, all the greases were pumped through a four-section Trabon header block connected to the hydraulically-operated grease cylinder by five feet of ¼ inch diameter copper tubing.

The grease in the cylinder and the particular set of copper tubing being used for evaluating that grease were placed in the cold box, brought to the test temperature

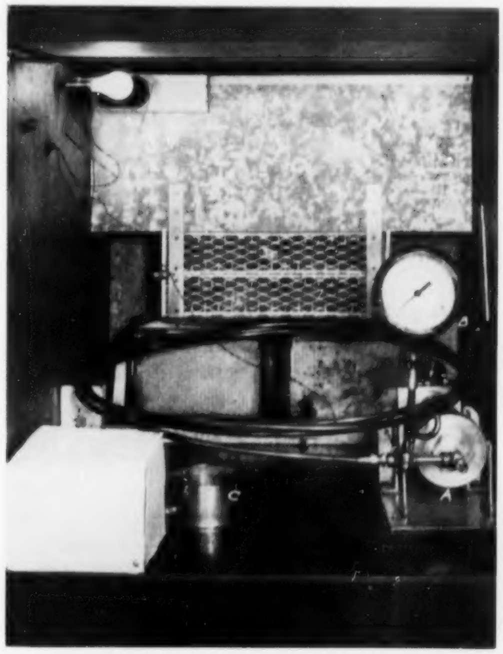


Figure 2. Mock set-up, centralized lubrication system.

and allowed to soak at that temperature for four hours before being pumped to insure a uniform temperature throughout the grease.

At each flow rate, the grease was allowed to pump for approximately five minutes before any data were obtained in order to permit the pressure to become stabilized.

The data obtained were the various flow rates and their corresponding pressures at each temperature. The flow rate was determined by catching and weighing the grease pumped during a timed interval.

The words pressure and pressure drop have been used interchangeably; however, both are used to indicate the amount of pressure required to pump the grease through a particular length of tubing. Since the end of the tubing

discharged at atmospheric pressure, the total pressure observed at the entrance of the tubing was actually the pressure drop.

The standard ASTM procedure was used on the pressure viscosimeter for determining the apparent viscosity of the greases, with the exception of running it at the three previously noted temperatures, 77°F., 50°F. and 32°F.

C. Products Used

Typical tests on the lubricants which are pertinent to the work covered by this investigation are given in Table I. These were selected as products which would give representative coverage of centralized lubrication system applications from the standpoint of NLGI grade, soap type and concentration and mineral oil type and viscosity.

TABLE I

Typical Tests on Centralized Lubrication System Greases

Grease	*A*	*B*	*C*	*D*	*E*	*F*	*G*
Test							
Soap:							
Type	*Ca*	*Li*	*Pb, Ca*	*Ca*	*Na*	*Na*	*Na, Ca*
Per Cent	11	8	14	9	5	16	23
NLGI Grade	1	2	1	[illegible]	0	3	2½
ASTM Penetration (Worked) at 77° F.	330	290	330	330	370	245	290
Mineral Oil:							
SUS Viscosity							
At: 100° F.	330	490	976	2393	4574	334	316
210° F.	34	37.9	76.8	88	192	48	46
Pour Point, °F.	−5	−10	+20	+10	+30	−25	+20

D. Data and Results

1. *Pressure Viscosimeter*

The data obtained on the pressure viscosimeter using standard methods, at temperatures of 77°, 50° and 32°F. are shown in Figures 3, 4, and 5.

From the curves shown in Figures 3*, 4 and 5, it may be noted that the seven greases can be generally grouped into two classes according to the slopes of their viscosity versus shear rate curves. The curves for greases C, D and E have a relatively flat slope, denoting a relatively small apparent viscosity drop with increasing shear rates. The curves for the remaining four greases have decidedly steeper slopes, indicating that increasing shear rates have a greater effect upon reducing their apparent viscosities.

*The apparent viscosity curve for grease G at 77°F. was not obtained.

These differences in the rate of change of apparent viscosity with shear rate may account for some of the deviations encountered in the construction of predicated pressure drop nomographs as will be discussed later.

The foregoing data will be referred to later under the discussion of the results of the mock centralized lubrication systems with respect to the correlation of apparent viscosity with pressure drops.

2. *Centralized Lubrication System, Mock Setup*

a. Preliminary Calibrations. Prior to making actual pumping tests on the greases, the copper tubing effective diameters were calculated by using Poiseuille's equation and flow data obtained with a heavy straight mineral oil of known viscosity. From this work it was found that the effective inside diameters of the ¼, ⅜ and ½ inch tubings were 0.183, 0.303 and 0.415 inch, respectively. Also performed were the calculations for the shear stress and shear rate constants which were used in determining the theoretical pressure drops. These values differ, of course, for each size of tubing. The constants were derived as follows from Poiseuille's general equation for the flow of Newtonian fluids, except that the apparent viscosity, N, was used instead of the absolute viscosity.

$$N = \frac{\pi P r^4}{8L\, v/t} = \frac{S}{R} \quad \frac{\text{Shear stress}}{\text{Shear rate}}$$

where N=apparent viscosity in poises
P=pressure dynes/cm²
r=radius of tubing cm
L=length of tubing cm
v/t=flow rate cc/sec.

Also $S = \frac{Pr}{2L} = C_s \frac{P}{L}$ where C_s=shear stress constant

And $R = \frac{4\, v/t}{\pi r^3} = C_r \frac{V}{T}$ where C_r=shear rate constant

In calibrating the copper tubing diameters, a highly filtered and dewaxed straight mineral oil with a viscosity of 8000 SUS at 100°F. was employed. The foregoing equation was also used, but the absolute viscosity of the oil, r, was substituted for the apparent viscosity, N.

b. Flow Rate Versus Shear Rate. The pumping tests

FIGURE 3

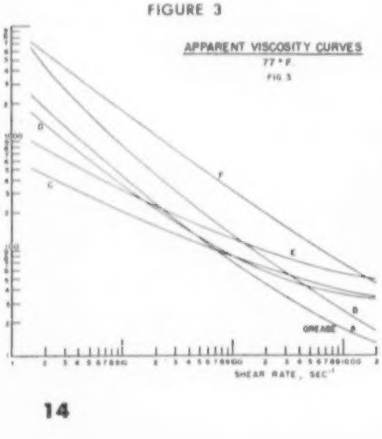


FIGURE 4

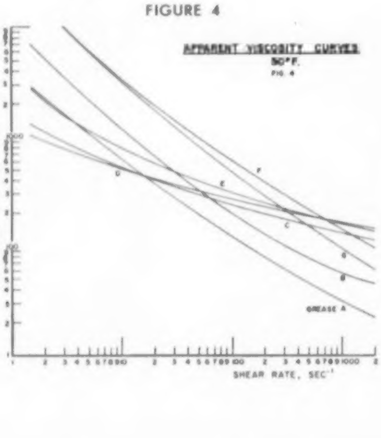
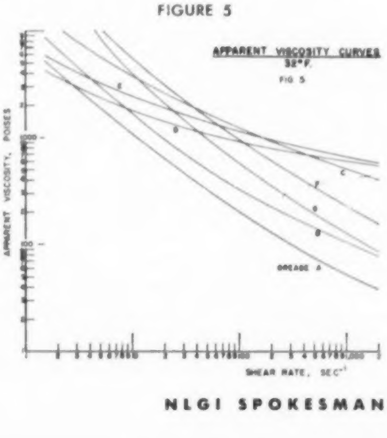


FIGURE 5



were conducted at flow rates from 15 to 120 grams per minute. By means of a variable speed transmission connected to the pump, the greases could be pumped at any flow rate desired. For this work, four nominal flow rates 15, 30, 60 and 120 grams per minute, were used for all the greases tested. These flow rates were chosen as being representative of the range encountered in multiple point centralized lubrication systems during the pumping cycle.

The shear rate, which was necessary for determining the apparent viscosity, was different for each flow rate as well as for tubing of different diameters. Therefore, to facilitate obtaining the shear rate, nomographs for the ¼, ⅜, and ½ inch diameter tubings were made, see Figure 6, covering flow rates from zero to 160 grams per minute. The shear rates shown on Figure 6 for the various flow rates were calculated using the effective diameter of the copper tubing as determined previously by calibration. Using this diameter should give the precise effective shear rate of the grease as it was being pumped through the tubing. To use the charts on Figure 6 for a given size tube, merely requires the selection of a flow rate on the right-hand scale and reading the corresponding shear rate on the left-hand scale. To illustrate, for a flow rate of 100 grams per minute the shear rate would be 168 $sec.^{-1}$ for ¼ inch tubing, 37.3 $sec.^{-1}$ for ⅜ inch tubing and 14.6 $sec.^{-1}$ for ½ inch tubing. From these scales it was also possible to determine the shear rate for a flow rate higher than 160 grams per minute or at any flow rate when a nomograph was not available by multiplying the flow rate by 1.684 for ¼ inch tubing, 0.373 for ⅜ inch tubing and 0.1454 for ½ inch tubing.

c. Pressure Drop Through Copper Tubing. During the early part of this work, it was found that the pressure drop through three ells or three tees of any diameter was approximately equivalent to the pressure drop through one foot of tubing of the same diameter. Therefore, in calculating the pressure drop per foot for the five feet of tubing plus three ells, or for the five feet of tubing plus three tees, they were considered as six feet of tubing.

From the pressure and flow rate data in the mock lubrication system, the calculated apparent viscosity and actual shear rate were calculated. Using this actual shear rate, the theoretical apparent viscosity for the particular grease was obtained from the pressure viscosimeter curves of apparent viscosity versus shear rate shown on Figures 3, 4, and 5. The calculated apparent viscosity was used only for comparison with the pressure viscosimeter apparent viscosity, shown in Figures 3, 4 and 5. Using the pressure viscosimeter apparent viscosity, the theoretical pressure required to pump the grease at each flow rate and the theoretical pressure drop per foot of tubing was calculated. This was compared with the actual observed pressure requirement and actual observed pressure drop per foot of tubing. Typical data are shown on Table II

TABLE II

Observed and Calculated Flow Data, Grease A, at 77°F., ½ Inch Tubing

Capillary Length, Feet	Observed Data Pressure p.s.i.	Observed Data Flow, G./Min.	$S = C_s P L$	$R = C_r v/t$	N (Calc.) = S/R	N (Theo.) from PV Plot	S (Theo.) = N x R	P (Theo.) SL / Cs	P Actual	ΔP/Ft. Theo	ΔP/Ft. Actual
50	195	14.1	2322.5	2.050	1133	1750	3585	301	193	6.02	3.86
50	225	28.0	2679.8	4.071	658	930	3790	318	222.7	6.36	4.45
50	255	58.8	3037.1	8.550	355	490	4100	344	252.5	6.88	5.05
50	275	106.5	3275.3	15.485	212	295	4560	383	272.3	7.66	5.45
50	190	12.7	2262.9	1.847	1225	1900	3505	295	188.1	5.9	3.76
50	210	27.7	2501.1	4.028	621	940	3780	318	222.7	6.36	4.45
50	240	58.5	2858.4	8.506	336	490	4160	350	237.3	7.0	4.75
30	270	102.0	3215.7	14.831	217	305	4520	380	267.3	7.6	5.35
25	92	14.0	2191.4	2.035	1077	1750	3560	149.5	90	6.0	3.6
25	105	28.1	2501.1	4.086	612	925	3780	159	103	6.36	4.11
25	120	58.9	2858.4	8.564	334	490	4200	176	117.5	7.04	4.7
25	135	106.5	3215.7	15.485	208	295	4560	192	132.3	7.68	5.3
25	85	14.0	2024.7	2.035	995	1750	3560	149.5	83	6.0	3.32
25	95	28.7	2262.9	4.173	542	905	3770	158	92.7	6.31	3.71
25	110	57.8	2620	8.404	312	495	4160	175	107.5	7.0	4.3
25	125	105.8	2977.3	15.383	194	295	4540	190	122.3	7.6	4.89
5	25	14.9	2977.5	2.1665	1374	1630	3570	30.0	21	6.0	4.19
5	27	27.7	3215.7	4.0276	798	940	3780	31.8	24.8	6.36	4.95
5	30	56.8	3573	8.2587	433	500	4130	34.7	27.5	6.94	5.49
5	33	108.8	3930.3	15.8195	248	290	4590	38.5	30.2	7.7	6.05
5	23	13.5	2739.3	1.9629	1396	1800	3530	29.6	21	5.92	4.2
5	28	29.4	3334.8	4.2748	780	890	3800	31.9	27.1	6.36	5.42
5	30	58.5	3573	8.5059	420	495	4205	35.3	27.5	7.06	5.49
5	34	106.4	4049.4	15.4706	262	295	4560	38.1	31.3	7.66	6.25

S=Shear stress, actual, N (Calc.)=Calculated apparent viscosity, S (Theo.)=Shear stress, theoretical, P=Pressure, actual=total pressure minus pressure required to pump grease through cylinder.

R=Shear rate, actual, N (Theo.)=Pressure viscosimeter apparent viscosity, P (Theo.)=Pressure, theoretical v/t=Flow, grams/min., L=Length of tubing, feet, Δ p.s.i./ft=Pressure drop per ft.

Shear stress constant, C_s=595.5, Shear rate constant, C_r=0.1454.

FIGURE 6

SHEAR RATE vs FLOW RATE FOR 1/4, 3/8 AND 1/2 INCH COPPER TUBING

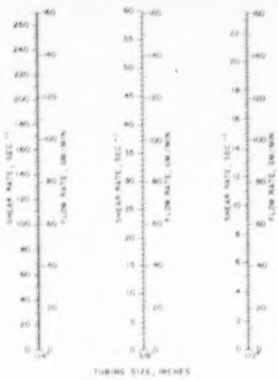
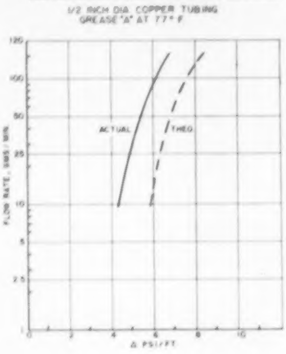


FIGURE 7

FLOW RATE vs PRESSURE DROP PER FOOT



for grease A at 77°F. when pumped through ½ inch diameter copper tubing.

It was found that the calculated theoretical pressure drops were generally greater than the actual pressure drops by between 15 and 25 per cent. In ultimately constructing nomographs of apparent viscosity, pressure drop and flow rate, the actual pressure drops from the mock system were used in making the correlation with the theoretical apparent viscosity. It would have been possible to construct the nomographs by pure mathematics. However, in this particular case, due to the complex nature of the equation involved, it was simpler and less time consuming to construct the nomographs graphically.

(1) *Construction of Nomographs.* The construction of nomographs correlating apparent viscosity, flow rate and pressure drop consisted primarily of three steps which were as follows:

a. Plotting curves of flow rate versus pressure drop per foot.
b. Plotting curves of pressure drop per foot versus apparent viscosity.
c. Graphical solution of nomographs.

Curves of flow rate versus pressure drop per foot were plotted for each of the greases at each of the temperatures at which determinations were made. In all cases both actual and theoretical pressure drops per foot were plotted; however, only the data from the actual pressure drop curves were used for the nomographs. These curves were plotted on semilog graph paper with the flow rate on the log scale and the pressure drop per foot on the linear scale. A sample of this is shown as Figure 7.

Using the above group of curves, six additional curves were plotted of pressure drop per foot versus apparent viscosity at constant flow rates of 10, 20, 35, 50, 70 and 100 grams per minute flow. Each of these curves incorporated data obtained at three temperatures, namely, 77°, 50° and 32°F., which gave a wide range of apparent viscosity values. These curves were plotted on log-log graph paper to cover the wide range of values encountered for both the apparent viscosity and the pressure drop. Plotting the data in this manner was also advantageous in that the points would theoretically fall on a straight line. The theoretical pressure drops fell on a straight line as expected. Also, for flow rates above 35 grams per minute, the actual pressure drops fell on a straight line; however, for flow rates of 35 grams per minute or less the actual pressure drops fell on a straight line only down to about 3 p.s.i., at which point the curve began to turn vertically downward and tended to become asymptotic to the apparent viscosity axis. Examples of the curves for the ½ inch diameter copper tubing for the 10, 35 and 100 g/min. flow rates are shown as Figures 8, 9 and 10. As the maximum deviation of individual points from the plotted curve was approximately five per cent, the resulting accuracy of the nomograph is approximately plus or minus five per cent.

The graphical solution for constructing the nomographs was obtained directly from the curves of pressure drop per foot versus apparent viscosity described above. In preparation of Figure 11 for ½ inch tubing, suitable scales were first constructed for apparent viscosity and flow rate. These were, of necessity, logarithmic scales. Once these were established, it became necessary to determine the location and unit size of the pressure drop scale. This was done by starting with the previously discussed curve for 10 grams per minute constant flow rate, Figure 8, and selecting apparent viscosities corresponding to various pressure drops per foot. Using these data, straight lines were drawn on Figure 11 between 10 grams

FIGURE 8

APPARENT VISCOSITY vs PRESSURE DROP PER FOOT

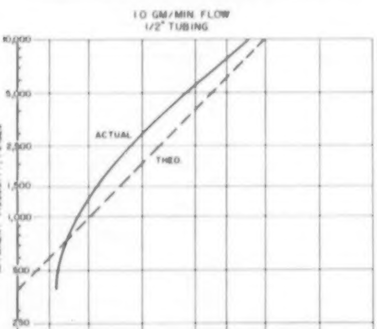


FIGURE 9

APPARENT VISCOSITY vs PRESSURE DROP PER FOOT

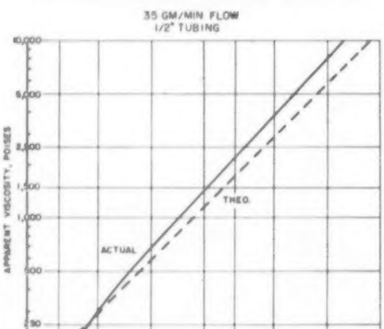
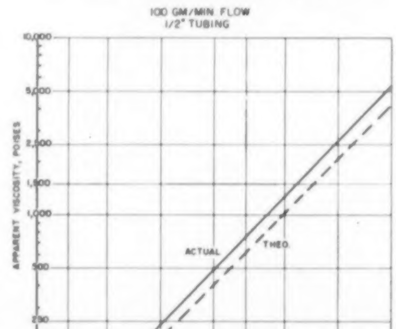
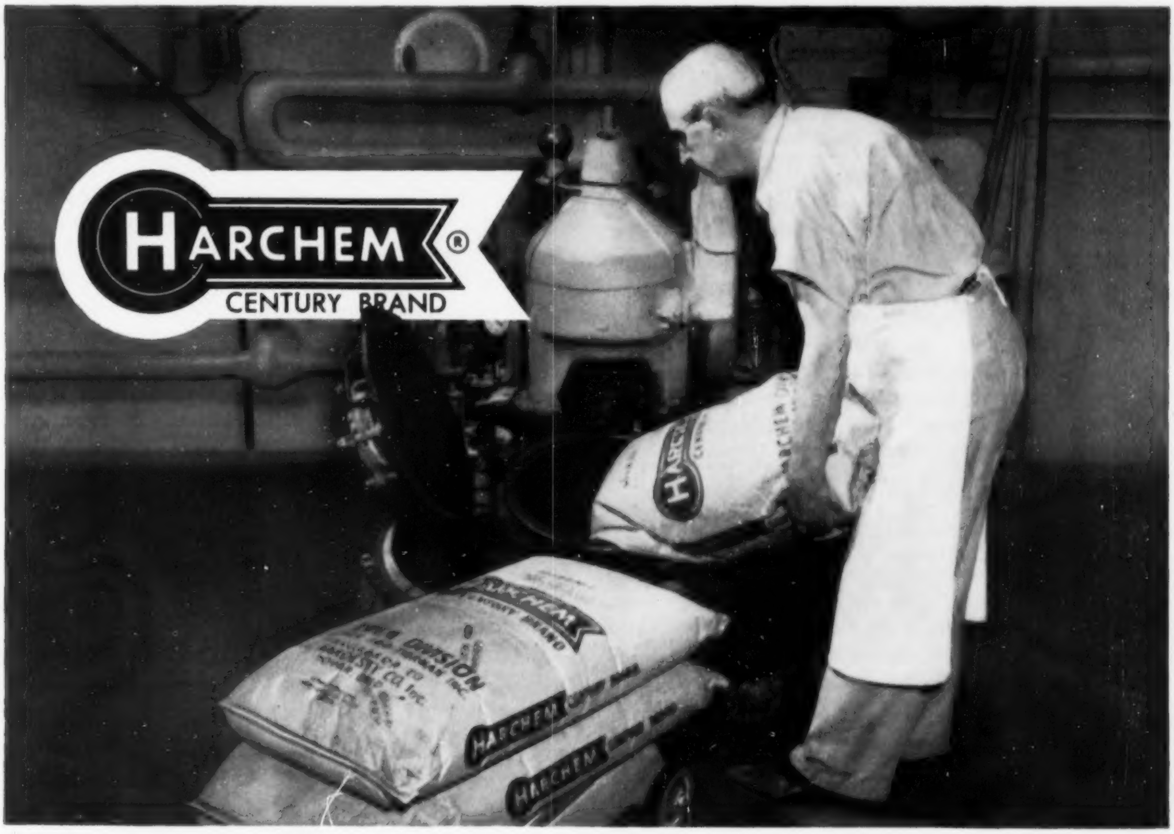


FIGURE 10

APPARENT VISCOSITY vs PRESSURE DROP PER FOOT

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flow rate and the appropriate apparent viscosities. This same procedure was followed using the 20, 35, 50, 70 and 100 grams per minute constant flow rate curves. After drawing these straight lines between the apparent viscosity scale and flow rate scale, it was seen that all the lines representing a 3 p.s.i pressure drop intersected at one point, as did all the lines representing 5, 10, 20 and 40 p.s.i. pressure drops. These points of intersection determined the size and location of the pressure drop scale.

This same procedure was also used for constructing nomographs for ⅜ inch and ¼ inch diameter copper tubing. These nomographs are shown as Figures 12 and 13.

(2) *Use of Nomographs.* To find the pressure drop per foot in a centralized lubrication system from the nomographs, it is necessary to know the diameter of the tubing, the grease temperature, the flow rate and the apparent viscosity for the product involved.

grease A at 77°F. at a flow rate of 50 grams per minute through ⅜ and ¼ inch diameter copper tubing, respectively.

d. Pressure Drops Through Trabon Header Blocks. In order to determine the total pressure drop of a system, it is also necessary to know the pressure drop through the header blocks as well as the pressure drop through the lines. Therefore, several tests on various arrangements of Trabon header blocks were made.

The Trabon header block on which most of the work was conducted consisted of four distributing blocks, two 10-T block sections and two 20-S block sections. The block numbers designate the amount of lubricant discharged in thousands of a cubic inch per stroke of the piston, and the letters represent the number of outlets, S=single outlet, T=two outlets. Thus, a 10-T block section indicates that for each stroke of the piston, 0.010

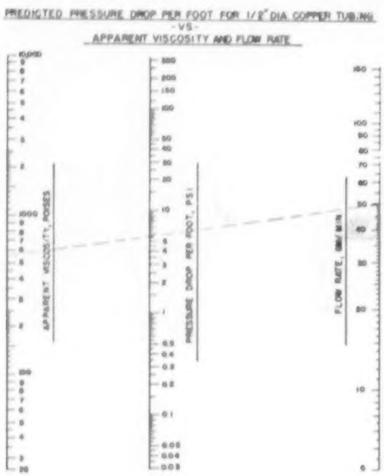

FIGURE 11

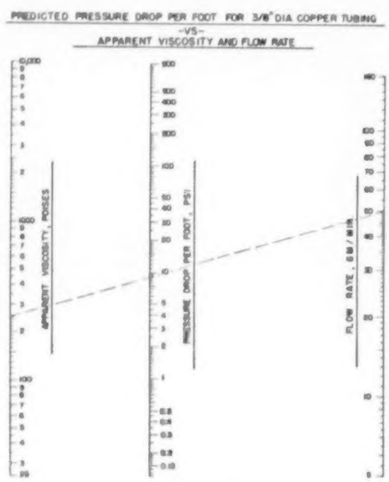

FIGURE 12

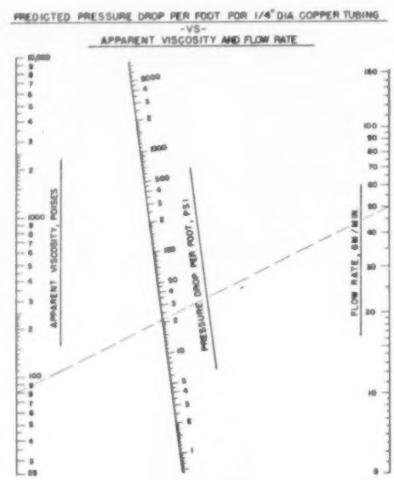

FIGURE 13

To illustrate the use of one of these nomographs, suppose that it is desired to obtain the pressure drop per foot of grease A in a system using ½ inch diameter tubing at a flow rate of 50 grams per minute and 77°F. ambient temperature. Using the chart on Figure 6 for ½ inch tubing, it is found that the shear rate is 7.2 sec. $^{-1}$. From the apparent viscosity curves on Figure 3, the apparent viscosity for grease A is 560 poises at 7.2 sec. $^{-1}$. Going next to the predicted pressure drop nomograph for ½ inch tubing, Figure 11, it is seen that for an apparent viscosity of 560 poises and a flow rate of 50 grams per minute, the pressure drop per foot is 5.6 p.s.i, illustrated by broken line.

In practice, there are very few systems which use only one size tubing. Since the pressure drop would be different for each size tubing, it would be necessary to determine the pressure drop for each size separately. The pressure drops could be combined to determine the total pressure drop of the system.

As a further example, the broken lines on Figures 12 and 13 show the predicted pressure drop per foot for

cubic inch of lubricant is discharged through each of two outlets. A 20-S block section discharges 0.020 cubic inch of lubricant per stroke of the piston through one outlet.

For this work, the Trabon header block was connected to the grease cylinder by five feet of ¼ inch diameter copper tubing. The greases were pumped at nominal flow rates of 15, 30, 60 and 120 grams per minute at temperatures of 32°, 50° and 77°F.

After data were obtained on all the greases using a four-section header block, two 10-T, and two 20-S, the header block was split so as to make two individual two-section blocks. With this arrangement one grease at one temperature was run. Data were obtained on grease A at 77°F. on the various combinations of header block sections and are shown on Table III.

As may be readily seen from Table III, the pressure drop for the two individual two-section header blocks were the same, 30 p.s.i., at the 10 grams per minute flow rate while at 120 grams per minute flow rate the pressure drop for the block with two 10-T sections was 10 p.s.i. higher than that of the two 20-S sections. This increase

in pressure drop was gradual, starting with no difference at 10 grams per minute flow rate and increasing about 10 per cent at 120 grams per minute flow rate. Using the four-section header block as a reference, the pressure drops of the two-section blocks were about 15 to 25 per cent lower. To check these results, it was decided to make a run on an eight-section block, data given in last column of Table III. The pressure drops of the eight-section block, two 10-T, two 20-S, two 30-S, two 10-S, were about 15 to 25 per cent higher than for the four-section blocks.

From Table III it may also be seen that the pressure drop through a header block was not directly proportional to the number of sections used. It appears that as additional sections were put into a block, the pressure drop would increase in smaller and smaller increments, although the data in Table III do not conclusively show this.

(1) *Construction of Nomograph.* The nomograph for the predicted pressure drop through a Trabon header block, two 10-T and two 20-S sections, was constructed by the same method that was used in constructing the nomographs for the various sizes of copper tubing.

Briefly, the construction was as follows: First, the observed data were plotted to get a group of curves of flow rate versus pressure drop through the block at the various temperatures. The second step consisted of using the above group of curves to plot seven additional curves of pressure drop through the block versus apparent viscosity at constant flow rates of 10, 20, 35, 50, 70, 100 and 120 grams per minute. Each of these curves incorporated data obtained at three temperatures, namely, 32°, 50° and 77°F. The apparent viscosity used in the second set of curves was equivalent to the apparent viscosity found at the shear rates in ¼ inch diameter copper tubing at the various flow rates. It was felt that this would be desirable since it would be very difficult to calculate the true average shear rate in a Trabon block because the channels and orifices of the blocks vary from about ⅛ inch diameter to about 5/16 inch diameter. Also, as the piston just begins to open or as it closes one of the ports, the opening will be very small and consequently the shear rate at these points will be very high.

After selecting suitable scales for the flow rate and apparent viscosity, constant pressure drop lines were drawn from a given flow rate. The intersections of these constant pressure drop lines located the pressure drop scale. The nomograph for predicted pressure drop through a four-section Trabon block is shown in Figure 14.

(2) *Use of Nomograph.* To find the pressure drop through a Trabon header block, two 10-T and two 20-S sections, it is necessary to know the temperature, flow rate and apparent viscosity of the product involved.

To illustrate the use of the nomograph shown in Figure 14, suppose that it is desired to determine the pressure drop for grease A through a Trabon header block at a flow rate of 100 grams per minute and 77°F. ambient temperature. Using the chart on Figure 6, for ¼ inch diameter tubing and a flow rate of 100 grams per minute the shear rate is 168 $sec.^{-1}$. It is found from Figure 3 that the apparent viscosity for grease A at 77°F. is 50 poises at 168 $sec.^{-1}$. Then using the predicted pressure drop nomograph for Trabon header blocks, Figure 14, with an apparent viscosity of 50 poises and a flow rate of 100 grams per minute, the resulting pressure drop is approximately 130 p.s.i.

CONCLUSIONS

1. A useful correlation of pressure drop versus apparent viscosity for several greases has been developed for ¼, ⅜ and ½ inch diameter copper tubing. For these products, a precision of approximately plus or minus five per cent was observed.

2. A useful correlation of pressure drop versus apparent viscosity using several greases has been developed for a Trabon header block, four sections. For these products, a precision of approximately plus or minus ten per cent was observed.

FIGURE 14

PREDICTED PRESSURE DROP THROUGH A TRABON HEADER BLOCK (2-10T, 2-20S) vs APPARENT VISCOSITY AND FLOW RATE

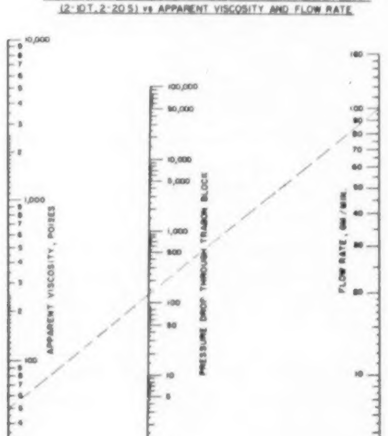

TABLE III

Pressure Drop (p.s.i.) Through Trabon Header Blocks
Grease A—77°F.

HEADER BLOCK SECTIONS USED

Flow Rate, g/min.	*Two 10-T*	*Two 20-S*	*Two 10-T, Two 20-S*	*Two 10-T, Two 20-S Two 30-S, Two 10-S*
10	30	30	47	62
20	47	45	56	67
35	58	54	68	77
50	76	71	79	88
70	90	83	95	102
100	105	96	120	130
120	111	101	139	148

PUMPABILITY
MILL

By J. S. AARONS

U. S. Steel Corp.

PART I—By J. S. Aarons

THE IMPORTANCE OF lubricants in the field of preventive maintenance is attracting greater and greater interest. There can be no argument put forth against the statement that satisfactory and efficient operation of a machine depends upon a material which will overcome the friction of that machine's moving parts. This material is the lubricant whether it be an oil or a grease. With this realization in mind, steps have been taken to improve lubricant application and slowly but surely the battered bucket and stick have been replaced by centralized pressure lubrication.

Centralized lubrication has brought untold blessings to machine operation. The dangerous condition of greasy and oily floors, the elimination for the most part of the human element in lubricating each bearing, and the savings effected in the more economical use of a lubricant are only a few of its advantages. But in order to further the use of these new methods of lubrication, the laboratory has been called upon to develop methods that would assist in picking out the proper greases, not only for the machine itself, but also materials that would show good pumpability or mobility characteristics for the centralized system under low temperature conditions. Dependent upon location mill temperatures are a very critical factor in determining the dispensing characteristics of greases.

In the type of service involved at the time the compression grease cup was developed, calcium soap cup greases of a No. 1 or No. 2 consistency were most widely used. In those days machinery so lubricated was subjected to less severe service than prevails today and rode largely on friction type sleeve bearings. Today, with the adoption of smaller bearing clearances and the perfection of high pressure units and centralized pressure greasing systems involving long lines, the flow characteristics of greases are becoming increasingly important.

Pumpability or mobility is that property which indicates how readily a grease can be moved in a lubricating system over a given temperature range.

In order to evaluate the mobility of greases there have been developed methods which have quite successfully determined this property. Unfortunately they are not practical in the limited space available to the small lubricants testing laboratory. A standard method of test has been adopted by the American Society for Testing Materials. This method is called Apparent Viscosity of Lubricating Greases. The test describes a procedure for measuring in poises the apparent viscosity of lubricating greases at room temperature.

A poise is the unit of absolute viscosity and is equal to one dyne second per square centimeter.

Apparent viscosity is the ratio of shear stress to shear rate.

Shear rate is the rate at which a series of adjacent layers of grease move with respect to each other.

Shear stress is the minimum force required to produce flow.

Lubricating oils are classed as true liquids at temperatures sufficiently above their pour points. Their viscosity or resistance to flow remains constant over a wide range of shear conditions for a given temperature. On the other hand, lubricating greases are oils thickened with soap and/or other solid materials to a plastic or semi-solid consistency. Their flow properties differ from those of oils in that the viscosity at a given temperature increases with decreasing shear rates. Therefore, greases are pseudo liquids and their resistance to shear under the conditions of any specific test is called the *apparent viscosity*.

The equipment used in making the determination of apparent viscosity is often called the pressure viscosimeter. The pressure viscosimeter apparatus consists of the following measure parts:

1. The power system—consists of a one-third hp 1750-rpm induction motor coupled to a 200 to 1 speed reducer. Interchangeable 40 and 64 tooth gears are used to drive the hydraulic pump.
2. The hydraulic system—a gear and a hydraulic oil reservoir having a capacity at least equal to the grease cylinder.
3. Gages.
4. The grease cylinder assembly—consisting of the cylinder and the floating piston and caps, with the piston moving the entire length of the cylinder without appreciable friction.

OF STEEL

GREASES

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Pittsburgh, Pa.

5. Capillaries—eight tubes of stainless steel, each of whose length is 40 times the actual orifice diameter. These diameters vary from 0.018 to 0.15 in.

Some laboratories have added refrigeration to study apparent viscosity of the lubricants at low temperatures. In this method the sample of grease is forced through a capillary by means of a floating piston actuated by an hydraulic system. From the predetermined flow rate and force developed in the system the apparent viscosity is calculated by means of Poisseuille's equation. A series of eight capillaries and two pump speeds are used to determine the apparent viscosity at 16 shear rates. A series of calibrated tests must be performed in order to standardize the hydraulic system and each capillary tube must also be calibrated.

The interpretation of results taken from the apparent viscosity determination of lubricating greases is not an easy task. In the hands of an experienced research worker it makes a very fine tool for the study of grease mobility but the data are too involved and much time is consumed in gathering the information. The reporting of so many poises at so many reciprocal seconds to the lubrication engineer will give rise to one question, "What do I do now?" The lubrication engineer demands a test that will give him a "go, no-go" answer on the grease in question and a test that will conform in its general outline to the conditions under which the material is being subjected.

Another method of test has been developed and studied for some time. This is the pumpability rate study using the air operated grease pumps. These pumps are of the high pressure service station type fitted with five feet or more of ¼-in. inside diameter hose and a central valve. These pumps are designed to pump from 100-lb. cartridges. Where information is desired at low temperatures, a cold room is used. It was found that approximately 24 hours was needed as a soaking period for a 35 to 40 lb sample of grease to assume the required test temperature. The tests are performed with 125 psi air pressure to the pump. The length of time and the amount of grease delivered for a number of complete cycles of the pump are then measured. Satisfactory correlation between these results and apparent viscosity determinations have been claimed. The size of the equipment, the need for a cold room, and the excessively large samples required for a successful test run have limited the test's utility as concerns small laboratory use.

For these reasons there was a need for a small compact machine needing no more than four sq. ft. of space and incorporating into it some of the features of both machines just described and featuring a test that could be completed in less than four hours. This machine with less than one year of background information developed shows promise in helping the lubrication engineer in his selection of greases where low temperature pumpability is a critical factor. In the ASTM method for apparent viscosity, the pressure required to move the grease through each of the capillaries is used for determining shear rate. In the grease mobility machine the pressure is kept at a constant rate and the amount of grease extruded, in a selected time interval through a single standard capillary at the required temperature, is reported in grams per second. No attempt has been made to correlate the results with apparent viscosity results and all figures gained through the use of this machine have been made only on a comparative basis.

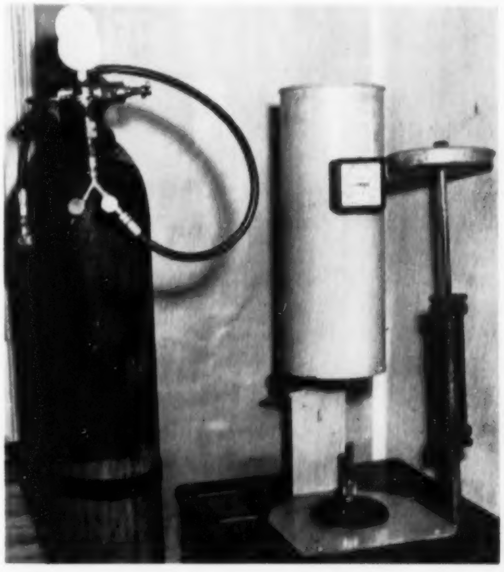
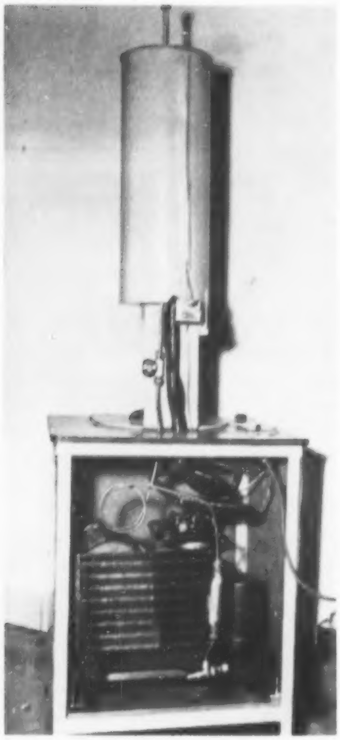


Figure 1. Pressure is obtained from a tank of nitrogen gas.



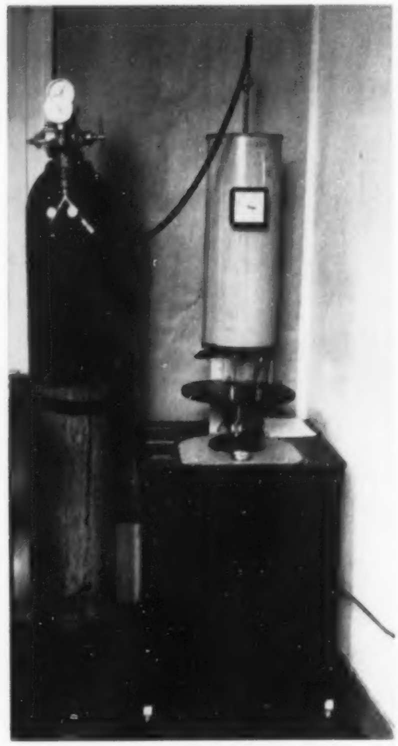


Figure 2. (Left). Cooling system can lower coil temperature to —36%.

Figure 3. (Above). Frost on cooling coils can be seen in this view.

Figure 4. (Right). Two beakers are mounted on an adjustable turntable under the cylinder.

The machine consists of the following parts:

1. The grease pressure cylinder which has been taken from the pressure viscosimeter. Included in this part is the floating piston, the top and bottom caps, and the No. 1—40 to 1 ratio capillary tube. The hole accommodating the thermocouple lead in the bottom cap has been securely plugged off. A 12-in. piece of ¼-in. inside diameter pipe with a union is attached to the top cap. See Figure 1.

2. A pressure system comprised of a tank of nitrogen gas delivered from a 2400-psi pressure tank through a pressure regulating gage which reduces the effective pressure as desired. This gage is so constructed that any pressure up to 250 psi can be maintained constantly. See Figure 1.

3. A cooling system consisting of a compressor powered by a ¼-hp motor, an enclosed cylinder of refrigeration coils containing No. 12 freon as a refrigerant and with sufficient capacity to lower the coil temperature to minus 36 F. See Figures 2 and 3.

4. A measuring unit consisting of an adjustable turntable having two recesses to accommodate two 250-ml breakers, one recess being ⅛-in. deeper than the other. See Figure 4.

5. A thermometer with a shaft diameter of 0.142 in. and calibrated to minus 40 F. A mirror is used for facilitating in taking temperature readings. See Figures 5 and 6.

PROCEDURE

The sample of grease, approximately one pound, is placed in the pressure cylinder with the aid of a grease gun filler, care being taken to eliminate air pockets trapped in the cylinder. The floating piston is then placed in the cylinder and the capillary is screwed tightly to the bottom cap. At this laboratory, the tests are usually begun in the morning and therefore the cylinders are filled the previous afternoon and placed in a refrigerator overnight; this lowers the temperature of the grease to approximately 40 F. At the start of the test, the cooling system is turned on and the grease cylinder is placed into the cooling compartment. A series of four 250-ml beakers are tared and marked to correspond to the test temperatures; namely, 32, 20, 10, and 0 F. In some cases, where required, a lower temperature of minus 10 F is also used.

The thermometer is inserted through the orifice of the capillary tube. The thermometer face rests against the bottom of the capillary tube and the shaft end extends up into the grease sample for 1¾ in. The mirror is adjusted so that readings can be easily made. The nitrogen tank is then connected to the cylinder top.

When the temperature reaches 32 F, the thermometer is removed and the adjustable turntable is set in place with two beakers—one a waste beaker, and the other the 32 F tare beaker so placed that the waste beaker is ⅛ in. higher than the tare beaker and flush with the bottom of the capillary tube. The reason for this is that the lift of the waste beaker becomes an effective knife edge and

TABLE I

	Base oil viscosity at 210 F, sec	Worked consistency at 77 F	Grease mobility in grams flow per second 32 F	20 F	10 F	0 F
High temperature, anhydrous calcium base,	65.0	315	0.501	0.180	0.063	0.022
water-proof grease	65.0	370	2.685	1.209	0.566	0.142
Steel mill roll neck grease with graphite filler........ ...	150.0	350	0.103	0.040	0.017	Nil
	80.0	340	1.127	0.524	0.204	0.11
	81.0	350	0.307	0.115	0.039	0.015
	64.0	302	1.57	0.59	0.24	0.156
High temperature lithium base grease....................	56.0	304	1.455	0.524	0.21	0.094
High temperature lithium base grease plus extreme	75.0	340	0.287	0.100	0.034	0.015
pressure agent	70.0	318	0.304	0.124	0.050	0.022

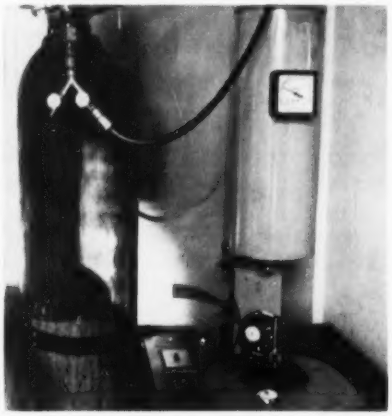


Figure 5. A mirror is used to help in taking temperature.

cuts the grease string cleanly before and after each time measured run. With the waste beaker in position the pressure is adjusted to 150 psi and when the extruded grease touches the bottom of the waste beaker, the platform is turned to set the tared beaker in place, a stopwatch is started, and a 30 or 60-second run is made. It will be at the discretion of the operator to decide the length of time for each determination. Since pumpability rates of some greases are very high, 15-second runs are sometimes made. After completion of the run, the turntable is moved once more so that the waste beaker is in place, the pressure is released, the system is vented, and the cooling system is turned on for the next lower temperature run. It has been established that the cooling rate approaches approximately 1 F drop per 4-6 minutes. To insure a stable temperature at the prescribed test points the cooling system is turned off at 2 F above the test temperatures.

Some typical results are given in Table I.

No analogy has been drawn between the apparent viscosity determination and the grease mobility test. The use of a constant non-pulsating pressure and the disregarding of the initial pressure at the moment of grease movement rules out this approach. However, there is a definite analogy between the air operated pump and the

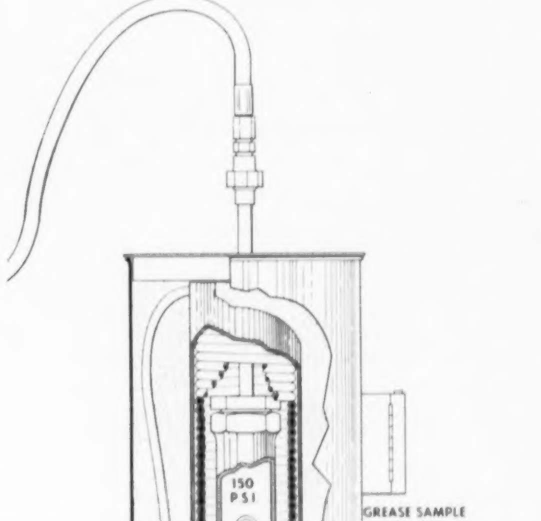


Figure 6. Cross section shows details of unit.

grease mobility test. A scaled down model of the air pump's features has been successfully made and can meet the requirements of a small laboratory operation. Reproduction of results on this machine using the same operator has been good. Spot checking of samples has shown a repeatability of 85-90 per cent. The most important phase of the test, that being the correlation of results with actual field practice, is discussed in Part II.

PART II—By R. G. Warren

Before devising this testing procedure, we had no rapid control method determining the mobility of a new grease under the different operating temperatures encountered in the steel mill.

Many operators have been confronted at one time or another with the problem of pumping grease through a centralized system. In order to clarify the method of procedure you might use to determine if a grease is suitable for pumping through a centralized grease system, let us briefly consider an actual case. A grease was offered to us which would reduce our cost of lubricant per ton by over 25 per cent. After extensive laboratory tests, we began to use it in the summer and fall. It was a No. 1 grade grease with an ASTM cone penetration of 320; and its performance, including pumpability, was satisfactory. As was our policy, we requested a No. 0 grade with an ASTM cone penetration of 360 for winter use commencing October 1. Unfortunately, no sooner had the No. 0 grade been used on the mill involved when we ran into high pressures on the centralized systems which were supplying the grease to the bearings. We had been operating at approximately 2200 psi when we changed to the No. 0 grade. An early check indicated that something was definitely wrong, and it was not the centralized system. A quick trip to the laboratory with a sample of each of the greases indicated the trouble. The first two columns of Table I give the results of the laboratory mobility tests on the No. 0 and No. 1 grades of the new grease.

The company supplying the grease was notified, and they sent their grease laboratory representative to discuss the matter with us. At first the representative felt we must be wrong in our observations, since at room temperature, the No. 0 grade had the consistency of soft butter on a warm day while the No. 1 grade was firm. We then repeated the mobility tests at the several low temperature levels and confirmed our original results.

A hurried test on the grease we had been using successfully for many years was rather startling. Note the difference in the last column of Table I.

TABLE I

Temperature F	New grease: No. 0 NLGI 360 penetration, gm/sec	New grease: No. 1 NLGI 320 penetration, gm/sec	Former grease: No. 1 NLGI 325 penetration, gm/sec
32	0.103	0.151	1.292
20	0.040	0.067	0.556
10	0.017	0.048	0.294
0	....	0.010	0.100

Obviously we had to improve the pumpability characteristics of the new grease if we were to be able to use it successfully in our systems in cold weather.

A few days later the supplier sent a sample of a modified grease for checking mobility.

We were still not satisfied so we requested them to try again. As a result, they submitted a sample of a second modification of the grease and the mobility tests of the two modifications are given in Table II.

TABLE II

Temperature	New grease: No. 0 NLGI 360 penetration, gm/sec	New grease: No. 1 NLGI 320 penetration, gm/sec	First modification	Second modification No. 1 NLGI 325 penetration, gm/sec	Former grease No. 1 NLGI 325 penetration, gm/sec
32	0.103	0.151	0.663	1.127	1.292
20	0.040	0.067	0.245	0.524	0.556
10	0.017	0.048	0.134	0.204	0.294
0	....	0.010	0.036	0.109	0.100

As you can see, we felt justified in giving the supplier the go ahead to make up a batch of the second modification grease for trial. It is not to be forgotten that the final grease submitted had to meet all our other standards set up for that particular type of grease in addition to being easily pumped. On putting the second modification grease on the mill, the pressure dropped back to 1650 psi.

Summarizing in brief, we are operating at 2200 psi with a No. 1 grade grease. Upon changing the grease to No. 0 grade, we had to increase the pressure to 2700 psi. Finally, we tailored-made a grease with the same pumpability characteristics as the one we had used for several years and the pressure dropped to 1650 psi. The chief modification made in the grease within a given grade was changing the viscosity of the oil. Our experience confirms the fact that, at lower temperatures, the pumpability of a grease depends more upon the viscosity of the oil it contains than upon the NLGI consistency of the grease.

There has been some criticism that perhaps we are tailoring our greases to fit the system while the important thing is to make a grease to lubricate the mills. We would be the first to agree that it is important to use a grease that will properly lubricate the mill. However, it is the job of the lubrication engineer to try first to obtain a grease suitable for the job that will work satisfactorily in the systems as they are, since it costs money to change systems. It would certainly be unwise to use a grease of inferior performance, however, due to any possible limitations of a particular method of applying the grease.

In conclusion, we might say that even though the grease submitted to any company was the best grease that it is possible to make and were given to us free of charge, it is of absolutely no value unless it can be pumped under the lowest temperature conditions you may encounter.

Reprinted from *Iron and Steel Engineer*, October, 1954.

Q and A

here is nlgi's discussion on flow properties of lubricating greases from the 1955 annual meeting

C. J. Boner, Battenfeld Grease & Oil Corporation: Probably Dr. Forster might comment on this. I believe that in considering possibility of flow, both Drs. Eyring and Forster were concerned with the soap molecules and their action. Now, presuming that we have an oil present, which we necessarily will have in our systems and that it would be of the one viscosity, say 100 SUS at 100°, what influence on your possible flow would be means by which the soap is immobilized? I think that it can be immobilized in some cases by absorption and in others by capillary attraction. Would you elaborate on that?

Dr. E. O. Forster, Esso Research & Engineering Company: I would like to ask you a question first. What is the difference between absorption and capillary interaction you mention?

Boner: My thought is that absorption is attractive forces due to the soap particles. Capillary attraction may be due to some attrac ion of the oil molecules themselves.

Forster: I believe the best explanation I can give you at the present time is that immobilization is due to interaction between the hydrocarbon part of the soap molecule and the hydrocarbon part of the oil phase. In other words, what I have referred to as attractive forces derived from induced dipole—induced dipole interaction in your terminology would be absorption forces.

Dr. I. J. Heilweil, The Texas Company: Dr. Eyring, in your treatment of viscosities of non-Newtonian systems, you make use of a factor X over Alpha and try to show the relationship between X over Alpha and concentration. Do you see any possibili.y of continuing this treatment in order to show whether there exists a direct dependence of X over Alpha and particle interaction?

Dr. Henry Eyring, University of Utah: The X is the fractional area on a slip plane of the various kinds of materials—the relaxation units and the

CHAIRMAN MARUSOV

BONER

WELTMANN

AARONS

Alpha is what I have related to the local stress. One has no way of separating those two parameters if one simply measures steady rate of flow. All that we have been able to do so far is given in the two papers published in the *Journal of Applied Physics* for August, 1955. The constants seem to be characteristic of structure. Maron and Pierce have examined the nature of these parameters extensively in a paper to appear in an early issue of the *Journal of Colloid Science*. We do hope to be able to systematize the values of these constants on the basis of molecular structure. To make such a systematization is the principle interest of our way of approaching the problem. We have high hopes.

this article concludes the material printed from the 1955 NLGI Annual meeting

Dr. R. H. Leet, Standard Oil Company (Indiana): Dr. Forster, with respect to your crystal studies in soaps, have you attempted to systematize or interpret the types of crystallization that you can get from different phases in the lithium and calcium soaps? Have you been able to determine the orientation of the molecules in different phase states?

Forster: Your question touches a very complex problem that has puzzled crystallographers for many years. In answer to your first part, you might be familiar with the fact that soaps crystallize in various forms. Sodium stearate, as far as I recall, has six different crystal structures which differ by their amount of water of hydration. The reason we are strictly speaking of lithium soaps, lithium stearate in particular, is the fact that they are the easiest to deal with and the simplest as far as phase condition goes. We have to worry about only three phases. In answer to the second part of your question, we are trying to do work similar to the Vold's work on calcium soaps; however, it will be some time before I could say that we have a definite answer to your question.

E. W. Nelson, Continental Oil Company: Dr. Forster, isn't it true that in a study of grease structure there is considerable possibility that the fiber structure itself changes due to different methods of handling? For instance, it seems to me there is considerable evidence in recent electron micrograph studies that some of the earlier conceptions do not give entirely true pictures of the original structure. A great deal seems to depend upon how the samples are handled and what techniques are employed in preparing the slides for the photographs. Would you care to comment on this apparent lack of agreement on what constitutes true grease structure?

Forster: As far as the preparation of samples for electro microscopy is concerned, we have tried the various methods described in literature and taken distinct pains to destroy the soap fibre structure by means of mechanical working. Some time ago, to be exact two years, we showed some results with the grease worker, where we showed the effect of structure deterioration by hundred thousand strokes grease working. The grease showed the same fibre structure as at the start. The hundred thousand strokes did not destroy the fibe structure. Working in the bearing of a truck did however destroy it completely. All of our evidence points to the fact that we have to do more than just subject the grease to low rates of shear operation. Recently at the ACS meeting in Minneapolis, a report was presented on the same subject by A. L. McClellan, et al, of the California Research Corporation. Afterwards a discussion ensued in which most everybody agreed that the sample techniques used at present do not alter significantly the grease structure as we observe them.

EYRING

LEET

FORSTER

Top—NELSON
Center—BRUNSTRUM
Bottom—KOENIG

Q and A

Continued on next page

Q and A

Continued

reproduced from actual recordings taken in Chicago

Forster: I would like to ask Miss Weltmann, in view of my interest in structure, if she would care to expand her structure number concept in terms of what we have been talking?

Miss Ruth Weltmann, NACA: There is not much to expand on the concept of the structure number. It is empirically obtained from steady state flow measurements and is useful for the practical identification of the flow behavior of some materials. I have called it structure number since it changes with solid concentration, particle shape, particle size distribution and relaxation time. To evaluate it in terms of molecular structure and relaxation time, dynamic measurements in addition to steady state flow measurements are required. A more theoretical approach to the evaluation of the structure of a material is the one proposed by Dr. Eyring. The coefficients in his flow equation and functions of the molecular structure and relaxation time. But again, dynamic and steady state measurements are required to evaluate the individual parameters contained in the coefficients, although the coefficients themselves can be obtained from steady state flow measurements alone.

L. C. Brunstrum, Standard Oil Company (Indiana): I would like to ask Miss Weltmann one question also. Will the grease industry eventually be forced to replace the long-established pressure viscometer?

Weltmann: I do not like to be a prophet here but I believe that the grease industry will eventually prefer to use rotational viscometers for certain flow measurements. That does not mean that the capillary tube viscometer will be completely out of the picture. It will always be useful for comparisons in flow behavior of different materials. My main reason for believing so is that a rotational viscometer, if well designed, provides almost constant shear rates across the test sample. This results in direct flow curve measurements (rate of shear versus shearing stress) which for most materials are representatives of the flow character of the tested material without the necessity of applying corrections. In a capillary tube viscometer the rate of shear changes from zero to a finite value. This frequently results in measured curves which are not at all characteristic of the flow type of the tested material. Since flow curves are essential for an interpretation of the flow behavior of non-Newtonian materials, they are then obtained by applying the necessary corrections which can be rather complicated.

When dealing with time-dependent, non-Newtonian materials the rotational viscometers have another advantage. The test sample remains in the test chamber and thus can be given a treatment which simulates industrial conditions by applying a constant rate of shear to the sample over a given period of time and by changing the rate of shear under fully controlled conditions in accordance with a desired program. This is not so easily possible in a capillary tube viscometer, since the sample is extruded from the capillary tube after each "point" measurement.

Forster: I would like to ask Mr. Koenig one question about his dispensing apparatus. When you described this apparatus, you said you let it run for five minutes at the temperature. Did you have, at the beginning of the experiment, your copper coil filled with grease or did you start to pump it into the cold copper coil?

E. F. Koenig, The Texas Company: The coil was filled with grease so that it soaked at that temperature.

Forster: Then in the five minutes, you actually more or less warmed up the layers of grease that were sliding against each other and you did not measure dispensability at the temperature you set it, but at some higher temperature because the internal friction might very well have raised the temperature?

Koenig: That is a possibility, but I would expect that the temperature rise would probably not be great enough to affect the measurements made.

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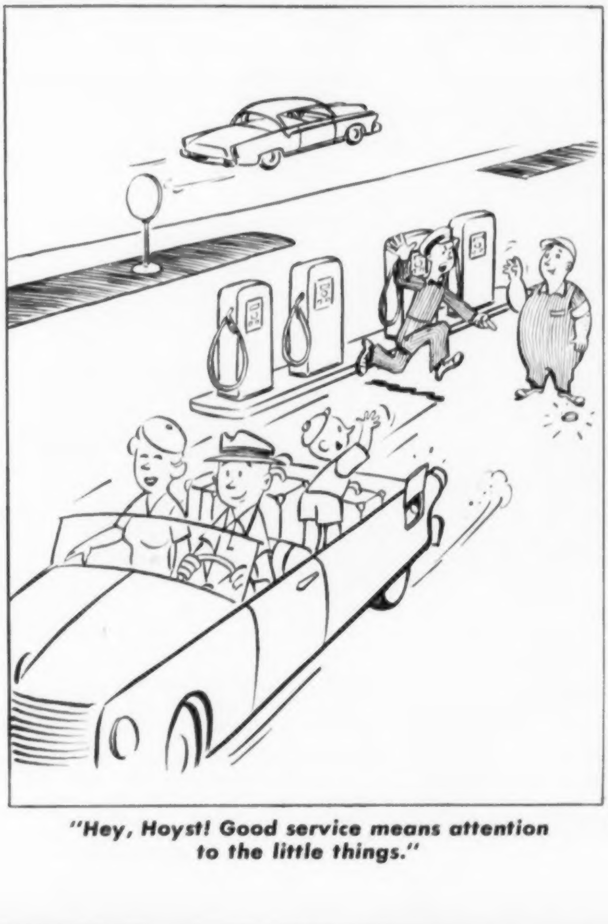
In a previous issue of this column it was indicated that plans were under way to organize a Symposium on the subject, "Laboratory Evaluations of Lubricating Greases for Automotive Ball Joint Front End Suspension." The Symposium referred to is that to be held as a part of the October 24, 1956, Meeting of the NLGI Technical Committee in Chicago. That plan has been dropped due to the difficulties encountered in lining up qualified kick-off speakers. We are, therefore returning to the type of subject favored in preceding symposia where the objective was to provide a forum for technical discussion of the progress made in the study of a fundamental characteristic of lubricating greases. It has been decided that the subject of the forthcoming Symposium will be a particular aspect of consistency of lubricating greases. The scope of the subject is indicated by the title of the paper which will be used to lead off the Discussion Period. The paper will be given by G. W. Eckert of The Texas Company Research Center, and is entitled, "A Method for the Prediction of the Hardness Changes of Greases in Storage." The following is an abstract thereof:

"A knowledge of the changes in hardness which greases undergo in storage is of importance to the producers and consumers of greases for several reasons. Since the actual determination of hardness changes during storage requires up to two years time, the need of an accelerated test is apparent. After preliminary trials of several possible methods, a test involving the ASTM oxidation bomb was evolved. An investigation of test variables included type of gas, pressure, temperature, and presence of moisture. The set of conditions finally selected were based on tests on products of different age-hardening tendencies. The method was proof-tested on additional greases of varying storage-hardening tendencies."

According to the present plans, at least two hours will be provided in the agenda of the Technical Committee Meeting for the Symposium. In other words, there is room for at least one more lead-off paper presenting data relative to the same subject. Therefore, members of the Technical Committee are urged to write promptly to L. C. Brunstrum, E. W. Nelson or T. G. Roehner if they know of other sources for papers which will contribute to the objective of this Symposium.

Hoyst Ledpantz... and *Lubricating Larry*



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"And I've checked on the map where you'll want to stop and lubricate every thousand miles."

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Patents and Developments

Use of Preformed Acid Salt in Soap-Salt Complex Greases

Soap-salt complexes are well known for thickening lubricating oils to produce lubricating grease compositions. These complex thickeners have been employed for high temperature greases and consist of combinations of metal salts of low molecular weight carboxylic acids with metal soaps of high molecular weight fatty acids. Normally the soaps and salts have been employed in proportions in the range of about 0.5 to 3 moles of salt per mole of soap. Because the thickening effect of the salt is rather low, it has been generally considered desirable to maintain the mole ratio of salt to soap below about 3 since above a mole ratio of about 3 the total requirement of soap-salt thickener needed to make greases of satisfactory penetration characteristics was found to be quite high.

However, recently it has been found that by drastically increasing the salt content and with it the metal content of soap-salt complexes, entirely new properties may be built into these complexes which greatly increase their value as grease thickeners. More specifically, it has been found that complexes of metal salts of low molecular weight carboxylic acids with metal soaps of high molecular weight carboxylic acids which contain at least 7 moles and up to as much as 40 moles or more, preferably about 8 to 25 moles, of the low molecular weight acid per hole of the high molecular weight acid have outstanding load-carrying, dispersant, and various other beneficial characteristics in addition to thickening properties comparable to soap-salt complexes containing substantially lower proportions of low molecular weight carboxylic acids.

Because of the difficulties encountered in handling large quantities of the low molecular weight acids and in particular acetic acid in the manufacture of these lubricating grease compositions which contain a complex soap-salt thickener having a high salt to soap ratio, it was recognized that it would be desirable to employ a preformed metal salt of the low molecular weight acid, such as calcium acetate, in the grease-making procedure in lieu of the direct use in the grease-making procedure of the low molecular weight acid itself. However, it was found that unsatisfactory greases were formed if the preformed metal salt constituted more than about 80% of the final salt portion of the complex soap-salt thickener. Thus it was not possible to completely eliminate the difficulties such as acid solidification, storage, pumping, etc., encountered with handling the low molecular weight acids such as acetic acid.

In U. S. Patent 2,735,815, issued to Esso Research and Engineering Company, it is claimed to have been found in the case where acetic acid is employed as the low molecular weight carboxylic acid that by employing an acid salt of calcium, barium, or strontium instead of the neutral acetate, it is possible to produce excellent greases without the necessity of employing any free acetic acid in the grease-making procedure. Although it will be clearly understood that these preformed acid salts may be employed in greases containing complexes having a salt to soap ratio below about 3, the method of this patent is especially useful in and is particularly directed to the preparation of lubricating grease compositions containing complex soap-salt thickeners in which there is a high ratio of salt to soap on a mole basis. More particularly, the patent is directed to lubricating grease compositions containing a complex soap-salt thickener wherein the ratio of salt to soap on a mole basis is at least 7 and up to as much as 40 or more and preferably about 8 to 25.

The preformed acid salts of this invention are generally considered as having the following formula

$$M(C_2H_3O_2)2 \cdot (C_2H_4O_2)n$$

where M is an alkaline earth metal selected from the group consisting of calcium, barium, and strontium, and n is an integer of 1 to 3. The acid salt is employed in the grease-making procedure in accordance with this patent in lieu of acetic acid and is used in combination with a high molecular weight carboxylic acid to form a complex soap-salt thickener. The complex is formed by neutralizing the free acid portion of the acid salt and the high molecular weight carboxylic acid with a basic reacting compound of a metal which is preferably the same metal as that of the acid salt. The neutralization reaction is preferably carried out in at least a portion of the lubricating oil which is to be thickened to a grease consistency by the complex soap-salt thickener. The mixture of the lubricating oil and neutralized acid salt and high molecular weight carboxylic acid is heated to an elevated temperature, preferably in the range of about 450° to 550° F. or higher, to dehydrate the product and to promote formation of the complex. The amount of the complex in the final lubricating grease composition may be in the range of about 5 to 30% by weight based on the total composition.

The acid salts may be conveniently prepared by reacting a hydroxide or carbonate of calcium, barium, or strontium with approximately the stoichiometric proportions of acetic acid required to produce an acid salt having the aforementioned formula. Thus, for example in the case of calcium, about 1 mole of calcium hydroxide (or calcium carbonate) may be reacted with about 3 moles of acetic acid to form an acid salt having the formula

$$Ca\ (C_2H_3O_2)_2 \cdot C_2H_4O_2$$

Also, by way of example in the case of barium, about one mole of barium carbonate or barium hydroxide may be reacted with about 5 moles of acetic acid to form an acid salt having the formula

$$Ba\ (C_2H_3O_2)_2 \cdot (C_2H_4O_2)3$$

The acid salts so formed are free-flowing powders or granules which may be simply and inexpensively stored and handled. When the metal hydroxide is employed, the powered acid salt contains all of the water of reaction. The reaction itself may be conveniently conducted at atmospheric conditions of temperature and pressure and is preferably carried out with intimate mixing of the reactants. The time required for completion of the re-

action is short and in view of the excess acid present is almost instantaneous. The acid salt may also be conveniently prepared by adding the appropriate number of moles of the neutral acetate salt to acetic acid. For example, about 1 mole of neutral calcium acetate would be added to about 1 mole of acetic acid to form an acid salt having the formula

$$Ca(C_2H_3O_2)_2 \cdot C_2H_4O_2$$

The high molecular weight carboxylic acids useful for this purpose are those having about 12 to 30 carbon atoms and preferably those having about 16 to 22 carbon atoms per molecule. These acids may be derived from saturated or unsaturated naturally occurring or synthetic fatty materials. The fatty acids normally used in the manufacture of conventional greases, particularly the more saturated acids, are preferred. Examples of such acids include stearic, hydroxy stearic, such as 12-hydroxy stearic, di-hydroxy stearic, poly-hydroxy stearic and other saturated hydroxy fatty acids, arachidic, hydrogenated fish oil and tallow acids, etc. However, unsaturated acids, such as oleic, ricinoleic and similar acids may likewise be used. It will be understood, of course that the naturally occurring or synthetic fatty materials mentioned above may be directly employed in the grease-making process to form soaps of high molecular weight carboxylic acids by treatment thereof with the basic metal reacting compound in the grease making process.

The lubricating oil employed to produce lubricating grease compositions in the method of this invention may be mineral as well as synthetic lubricating oils having a viscosity of at least 30 SSU at 100° F. such as esters of monobasic acids (e.g. ester of C_8 Oxo alcohol with C_8 Oxo acid, ester of C_{13} Oxo alcohol with octanoic acid, etc.), esters of dibasic acids (e.g. di-2-ethyl hexyl sebacate, di-nonyl adipate, etc., esters of glycols (e.g. C_{13} Oxo acid diester of tetraethylene glycol, etc.), complex esters (e.g. the complex ester formed by reacting one mole of sebacic acid with two moles of tetraethylene glycol and two moles of 2-ethyl-henanoic acid, complex ester formed by reacting one mole of tetraethylene glycol with two moles of sebacic acid and two moles of 2-ethyl hexanol, complex ester formed by reacting together one mole of azelaic acid, one mole of tetratethylene glycol, one mole of C_8 Oxo alcohol, and one mole of C_8 Oxo acid), esters of phosphoric acid (e.g. the ester formed by contacting three moles of the mono methyl ether of ethylene glycol with one mole of phosphorus oxychloride, etc.), halocarbon oils (e.g. the polymer of chlorotiffuoro-ethylene containing twelve recurring units of chlorotrifluoroethylene), alkyl silicates (e.g. methyl polysiloxanes, ethyl polysiloxanes, methyl-phenyl polysiloxanes ethylphenyl polysiloxanes, etc.), sulfite esters (e.g. ester formed by reacting one mole of sulfur oxychloride with two moles of the methyl ether of ethylene glycol, etc.), carbonates (e.g. the carbonate formed by reacting C_8 Oxo alcohol with ethyl carbonate to form a half ester and reacting this half ester with tetryaethylene glycol), mercaptals (e.g. the mercaptal formed by reacting 2-ethyl hexyl mercaptan with formaldehyde), formals (e.g. the formal formed by reacting C_{13} Oxo alcohol with formaldehyde), polyglycol type synthetic

oils (e.g. the compounds formed by condensing butyl alcohol with fourteen units of propylene oxide, etc.), or mixtures of any of the above in any proportions. Quite generally the mineral of synthetic oil should have a viscosity within the range of about 35 to 200 SSU at 210° F. and flash points of about 350° to 600° F. Lubricating oils having a viscosity index of 100 or higher may be employed. However, oils of lower viscosity index such as below VI give better yields. Complex salt-soap proportions of about 5 to 30 wt.% and preferably about 10 to 20 wt. per cent based on the total grease composition may be employed in preparing grease compositions in accordance with the method of the patent.

The preferred grease-making procedure of this invention comprises the formation initially of a mixture of the acid salt, the high molecular weight carboxylic acid, and a basic reacting compound, such as the hydroxide, of a metal which is preferably the same as the metal in the acid salt in a portion or all of the lubricating oil which is to be utilized in the grease composition. Preferably at least one-third of the total lubricating oil is utilized in the preparation of this initial mixture. The free acid portion of the acid salt and the high molecular weight carboxylic acid are neutralized by the basic reacting compound. A sufficient amount of the basic reacting compound is employed to accomplish this neutralization. It will be understood that the term "free acid portion of the acid salt" as used herein refers to the right hand portion of the afore-mentioned formula, namely the

$$(C_2H_4O_2)n$$

group. The high molecular weight carboxylic acids and the acid salt may be co-neutralized by adding the basic reacting compound to the oil mixture containing both the acid salt and the high molecular weight carboxylic acid, or the carboxylic acids may be neutralized in a stepwise procedure. If the stepwise procedure is employed the high molecular weight acid may be added to the oil mixture containing the basic reacting compound first, followed by the addition of the acid salt. Thereafter the lubricating oil containing the neutralized materials is heated to an elevated temperature preferably in the range of about 450° to 550° F. or higher to dehydrate the product and to promote formation of the complex. Generally a period of heating in the range of about 10 to 30 minutes will be suitable to effect the formation of the complex. Thereafter the composition is cooled and the remainder of the lubricating oil is added in the case where only a portion of the lubricating oil was initially employed. It will be understood, however, that, if desired, the acid salt and the high molecular weight carboxylic acid may be neutralized together in a separate step and then added to the lubricating oil after which the mixture is heated to an elevated temperature in the range of about 450° to 550° F. to promote formation of the complex. It will be further understood that other conventional thickeners, anti-oxidants, corrosion inhibitors, tackiness agents, load-carrying compounds, viscosity index improvers, oiliness agents and the like may be added prior, during or after the heating step.

The following example is presented to more specifically set forth this invention, but it will be understood

that it is not intended that the example limit the present invention in any way.

Lithium Soap Grease with Phosphate Ester Vehicle

In recent years, a demand has been created for greases of outstanding lubricating character which retain their grease structure during use over a wide range of operating temperatures. For efficient aircraft operation, greases should have low temperature torque properties such that they will flow properly at temperatures as low as about -70° F. In addition, the greases should be of low volatility and retain their grease structure at temperatures at least as high as 300° F. Failure to retain grease structure results in high consumption of grease and frequent servicing. Other desirable features of such greases are: homogeneity and smooth, unctuous consistency; water resistance; resistance to oxidation; resistance to oil separation; and resistance to sheer or breakdown upon working or milling.

It is claimed that the demand for greases of the foregoing specification has not been satisfied to date, except by resort to expensive operating procedures. It has been found, for example, that lithium base greases containing synthetic vehicles comprising esters of dibasic acids, such as di-(2-ethyl-hexyl) sebacate and di-(iso octyl) adipate, are suitable for low temperature operations; and, in fact, such greases are used in aircraft, as reflected in Military Specification MIL-G-3278. The latter greases have the desired homogeneous nature and smooth consistency, and have satisfactory water resistance. Yet, these lithium base greases have a weakness in that their ester vehicles have excess volatility at temperatures of 300° F. and higher. Such a loss is too great for long service life of the greases in anti-friction bearings. Another shortcoming of such greases is their lack of extreme perssure (E.P.) properties, necessitating incorporation of an additive material imparting E.P. characteristics. One approach taken to effect improvement of lithium base greases involves a special film-cooling technique to obtain satisfactory grease structure. But, film-cooling is a slow and expensive procedure requiring special equipment. Another approach taken to effect such improvement involves the use of a lithium soap of 12-hydroxy stearic acid and quick cooling. Still another approach involves the use of a very high soap content grease. A further means adopted to improve grease structure is the use of a mixed soap, namely the use of a calcium soap in admixture with the lithium soap. However, lithium-calcium base greases are deficient in mechanical stability and have lower melting points, thus requiring their use at lower operating temperatures (e.g., below 250° F.).

According to U. S. Patent 2,737,493, issued to Socony Mobil Oil Company, Inc., it is possible to readily provide a lithium base grease of low volatility and having excellent extreme pressure lubricating power, and stable when used at temperatures varying from -70° F. to 300° F. and higher, using conventional grease-making equipment.

The vehicles or synthetic oils of the greases contemplated are confined to alkyl, aryl phosphate esters, represented by the following general formula:

$$\begin{array}{l} R{-}O \\ \qquad\diagdown \\ R_1{-}O{-}P = O \\ \qquad\diagup \\ R_2{-}O \end{array}$$

wherein R is alkyl, R_1 is aryl and R_2 is either alkyl or aryl, typical of which groups are: (1) alkyl such as methyl, ethyl, propyl, butyl, amyl, 2-ethyl hexyl, iso octyl, etc. (2) aryl such as phenyl, and its alkylated derivatives such as cresyl, amyl phenyl and the like. Representative of such esters are: dibutyl, mono-phenyl phosphate; di- (2-ethyl-hexyl), monophenyl phosphate; and mono iso octyl, disphenyl phosphate. Particularly advantageous of such esters is dibutyl, mono phenyl phosphate.

In general, the synthetic vehicles described above and contemplated for use in the greases have a viscosity from about 40 seconds to about 150 seconds, S.U.V. at 100° F. Particularly desirable are those having a viscosity of the order of 50 to 60 seconds, S.U.V., at 100° F. The vehicles also have low pour points and low evaporation rates at elevated temperatures.

Physical characteristics of several typical phosphate esters are presented below in Table 1.

TABLE I

	Di (2 Ethyl Hexyl), Mono Phenyl Phosphate	*Di Butyl, Mono Phenyl Phosphate*	*Iso Octyl, Diphenyl Phosphate*
Flash, C.O.C., °F.	385	370	455
Fire, C.O.C., °F.	460	395	480
Visc. @ 100° F., SUS.	54	52	61
Visc. @ 210° F., SUS.	34	36	35
Viscosity Index	80	205	73
Pour, °F.	Below -60	Below -70	Below -60
Specific Gravity	0.9916	1,0663	1,097

The lithium fatty acid soap constituting one of the soap or gelling components of the greases of this patent, is prepared with a fat or fatty material containing from about twelve to about twenty-two carbon atoms per molecule. Representative of such materials are vegetable, animal and fish fatty oils, and hydrogenated materials thereof. Stearin, stearic acid, cottonseed oil acids, oleic acid, palmitic acid, myristic acid, 12-hydroxy stearic acid, hydrogenated fish oils such as "Hydrogenated Fish Oil, Iodine No. 77" and "Hydrofol" are typical. Preferred soaps, however, are lithium stearate and the lithium soap of 12-hydroxy stearic acid.

The lithium and aluminum salts contemplated as modifying agents are salts of aliphatic monocarboxylic acids having from about six to about ten carbon atoms per molecule. Typical of such salts are lithium and aluminum salts of: hexanoic, heptanoic, octoic such as caprylic and 2-ethyl hexanoic, perlargonic and decanoic. Particularly preferred herein are lithium and aluminum octoates.

In connection with the above-mentioned modifying agents, it has been found that satisfactory grease gels could not be formed from the phosphate ester vehicles and lithium soaps described above when the modifying salts were absent. It has also been found that conventional metal soap types, such as calcium and magnesium stearates do not form gels with the phosphate esters with or without the modifying salts. It was further found that when certain proportions of the lithium and/or aluminum salt modifying agents were used with the phosphate ester vehicles and lithium soaps, excellent grease gels could be formed. The lithium and/or aluminum salts are used in amounts of the order of 0.2 per cent to about ten per cent by weight of the grease. Generally, however, particularly advantageous behavior is realized with from about one to about three per cent of the modifying agent, with balanced proportions of the phosphate ester vehicle and lithium soap. The latter comprises from about four to about thirty per cent of the grease, and the vehicle from about sixty to about ninety-four per cent of the grease. For convenience, these balanced proportions are shown below in tabulated form:

	General	*Preferred*
Lithium Soaps	4-30	8-15
Lithium and/or Aluminum Salt	0.2-10	1-3
Phosphate Ester Vehicle—Balance to 100 per cent, e.g.	60-94	82-91

The greases of this patent can also contain other characterizing ingredients. For example, they can contain lubricity improving agents such as free fat, free fatty acids, esters of alkyl and/or aryl esters, sulfurized fats, lead soaps, etc. These characterizing materials do not detract from the lubricating value of the greases contemplated herein nor do they detract from the beneficial properities imparted by the lithium soap and the lithium and/or aluminum salt, rather, these characterizing materials serve to impart their customary properties to the grease. In general, the characterizing material or materials are present, in total, in amounts up to about five per cent by weight of the grease.

By way of illustration, the greases can be formed in the following manner. A preformed lithium soap and a preformed lithium and/or aluminum salt are mixed well as room temperature, about 70-80° F. with a phosphate ester vehicle. The resultant mixture is heated to a temperature from about 90° F. to about 500° F., preferably about 420° F., with constant stirring, during a period of thirty minutes to about two hours, depending upon the quantities of materials used. After the time period indicated above, the resulting liquid product is cooled to room temperature, generally requiring a period of about

one to ten hours. The cooled grease product is milled to a buttery product in a suitable milling apparatus, such as Cornell homogenizer. When any additives are incorporated in the greases it is advisable to add them just prior to cooling the products.

Stable Greases Containing Synthetic Gelling Agents

Recently, a new group of grease compositions has been developed from metal soaps of partial esters and partial amides of acidic copolymers of alpha, beta unsaturated polycarboxylic acids or their anhydrides with low molecular weight compounds having a terminal vinyl group ($-CH\ CH_2$). These grease compositions are described in detail Patent No. 2,698,297. While the grease compositions described in this patent have an excellent combination of properties and have outstanding performance characteristics, they tend to stiffen on standing. That is, the greases can be milled to a smooth, plastic mass but, on standing, they often become stiff and elastic or rubbery.

In U. S. Patent 2,737,494, issued to Socony Mobil Oil Company, Inc., it has been found that certain polymeric materials, incorporated into these greases in relatively small proportions, effectively reduce or even eliminate this undesirable characteristic. In addition, in some instances the plasticizing effect of the polymeric material increases the dropping point of the grease to 400° F. and higher.

The patent is claimed to provide greases containing the aforesaid metal soaps of acidic copolymers, having a high degree of stability. Such greases contain stabilizing polymeric materials having average molecular weights of 10,000-100,000, and including the following:

(1) Olefin polymers, such as polymers of alpha monoolefins having up to about eighteen carbon atoms per molecule, typical of which are polymers of propylene, isobutylene, decene, particularly polypropylenes having an average molecular weight of about 100,000, and polyisobutylenes having an average molecular weight of about 100,000; and alkylated polystyrenes, particularly polystyrenes alkylated with C_8-C_{12} olefins;

(2) Ester polymers such as polymers of alkyl methacrylates, alkyl acrylates, vinyl esters;

(3) Esterfied reaction products of an alpha, beta-unsaturated dicarboxylic acid anhydride and vinyl acetate, which reactions products are esterified with a saturated aliphatic alcohol containing between about 12 and about 18 carbon atoms in a straight chain; such esterified products are described in Patent No. 2,616,851.

(4) Products obtained by copolymerizing vinyl and/or alkyl ethers with alpha, beta-unsaturated dicarboxylic acids or their anhydrides, such product being esterified with primary, normal saturated aliphatic alcohols containing up to about eighteen carbon atoms per molecule;

(5) Esters of thiophene-modified, maleic anyhdride-styrene copolymers; described in Patent No. 2,600,798.

The polymeric materials are used in amounts of the

order of from about one per cent to about ten per cent, by weight, of the total grease composition. Preferably, the amount of polymeric material will fall within the range of two to five per cent.

The novel soaps of the greases are metal soaps of partial esters and of partial amides obtained by reaction of an aliphatic alcohol having at least about eight carbon atoms per molecule or an aliphatic amine having at least about eight carbon atoms per molecule, respectively, with an acidic copolymer of a lower molecular weight vinyl compound, such as styrene or vinyl acetate, with an alpha, beta unsaturated polycarboxylic acid or anhydride.

Example

Seventy-three and one-half parts by weight of styrene and 49 parts by weight of maleic anhydride were dissolved in 1,000 parts by weight of toluene. The resulting solution was heated to 150° F. and 1.23 parts by weight by benzoyl peroxide were added. Heating was continued to about 200° F. where reaction took place as evidenced by clouding of the solution. Heating at reflux about 220° F.) was continued for one hour. The styrene-maleic anhydride thus formed was partially esterified with a mixture of 93.6 parts by weight of Lorol 5 alcohol and 9.9 parts by weight of n-octadecanol, using 4.54 parts of paratouluene sulfonic acid as catalyst, at 300° F. for two hours. The resulting partial ester had a neutralization number of 121.0.

Lorol 5 alcohol is a mixture comprising 2.8 per cent n-decanol, 61.0 per cent n-dodecanol, 21 per cent of n-tetradecanol, 11.0 per cent of n-hexadecanol and 2.2 per cent of n-octadecanol.

Eighty parts by weight of the partial ester, described above, 371 parts by weight of an acid-refined naphthenic oil (232 S.U.S. at 100° F.) and 8.7 parts by weight of $LiOH.H_2O$ dissolved in 78.0 parts by weight of water, were mixed in a suitable grease kettle and heated to 400° F. over a four hour period. The resulting grease was stirred while cooling to room temperature (80° F.) The soap concentration was eighteen per cent.

A portion of the resulting grease was blended with ten per cent by weight of polyisobutylene (20 per cent polymer in oil; average molecular weight of polymer, about 100,000), and with sufficient oil to reduce the soap content to sixteen per cent. The final grease did not stiffen and actually showed a higher dropping point. The dropping point of the grease without polyisobutylene was 280° F.; whereas, the dropping point of the grease with polyisobutylene was above 400° F.

With regard to preparing the greases of this invention, the polymer is added at the last stages of the preparation. That is, after the grease containing a metal soap, or soaps, of a partial ester or partial amide of the type described above, has been prepared, the polymer is added and is thoroughly dispersed or admixed therein. No improvement is realized when the polymer is incorporated during the preparation of the grease.

Farval Corporation Joins

NLGI Welcomes

The Farval Corporation

As an

Associate Member

NEW MEMBER

The Company was founded in 1926 as Lubricating Devices, Inc. of Battle Creek, Michigan. It developed the first successful centralized lubrication systems for industrial applications and has been engaged exclusively in the manufacture of industrial centralized lubrication systems ever since.

In 1931, Lubrication Devices, Inc., was purchased as a wholly-owned subsidiary by The Cleveland Worm & Gear Company of Cleveland, Ohio, and the following year, the corporate name was changed to The Farval Corporation, and the factory and general offices were moved to Cleveland, Ohio.

Since its affiliation with The Cleveland Worm & Gear Company, the Farval Corporation has enjoyed a steady growth and is now recognized as a leader in the Centralized Lubrication Equipment Industry.

NLGI Is Proud to Welcome the Following New Members Who Have Joined Within the Last Year:

Active Members

Metalcote Grease & Oil Company
St. Paul, Minnesota

Lubrificanti Gazelle
Milano, Italy

Inter-State Oil Company
Kansas City, Kansas

Associate Members

Barrett Manufacturing Company
Houston, Texas

Humko Company, Trendex Division
Memphis, Tennessee

National Lead, Steel Package Division
St. Louis 1, Missouri

McGean Chemical Company
Cleveland, Ohio

American Can Company
Kansas City, Missouri

Struthers-Wells Corporation
Warren, Pennsylvania

American Flange & Manufacturing Co.
New York, New York

American Potash & Chemical Company
New York, New York

C. P. Hall Company of Illinois
Chicago, Illinois

Marketing Members

Denco Petroleum Company
Cleveland, Ohio

Ohio Farm Bureau Cooperative Assn., Inc.
Columbus, Ohio

Illinois Farm Supply
Chicago, Illinois

Ampol Petroleum, Ltd.
Balmain, New South Wales, Australia

Technical Members

Products Development Laboratory
West Warwick, Rhode Island

Battelle Memorial Institute
Columbus, Ohio

At the Edgewater Beach • Chicago • October 22-24

YOUR 24TH NLGI ANNUAL MEETING

A program of far-reaching interest is being prepared for those attending the 24th Annual Meeting of the National Lubricating Grease Institute in Chicago this October. An important figure from the automotive industry will speak on "Safety on the Highway" . . . part of the symposium will be a paper on "A Method for the Prediction of the Hardness Changes of Greases in Storage" . . . still another presentation will be "Atomic Energy—Weapon for Peace." This is just some of the idea-producing material available to NLGIers and friends at the Edgewater Beach Hotel, Monday through Wednesday, October 22-24. This year's meeting promises to be the biggest and best yet, and you are urged to make your reservations for the three-day session which will encompass the latest developments of the lubricating grease industry.

PEOPLE

Shell Announces Personnel Changes in Marketing

Three personnel changes in Shell Oil Company's marketing department were announced by J. G. Jordan, vice president.

W. A. Burnett, distribution superintendent of the New York division, will become manager of the fleet division, marketing distribution, in head office, New York.

Mr. Burnett replaces J. M. McGinnis, who will become operations manager for the Boston division.

W. L. Shaw, Boston operations manager, will become operations manager in Los Angeles, replacing C. P. Woodward who is on a leave of absence.

A California Native

Mr. Burnett, a native of San Francisco, attended the University of California before joining Shell as a supervisor in the New York operations department, in 1930. After serving in various positions of increasing responsibility in the plant department for more than five years, he was named assistant engineer in the operations-engineering department. In 1951, he was transferred to Jackson Heights as superintendent of operations for the New York division. He was named to his present position in 1953.

Mr. McGinnis was born in St. Louis. He joined Shell in St. Louis as a stock and tool room clerk in 1929. He was transferred to Cleveland as a plant superintendent in 1939, and has since served in New York and Boston as head office automotive representative and manager of the operations department respectively. He was named manager of the motor fleet division in 1953.

Mr. Shaw received his A.B. and M.A. in architecture and engineering from the University of California before joining Shell in San Francisco in 1933 as a trainee in the sales department. After serving in various positions of increasing responsibility in the marketing department on the West Coast, he was named manager of the plant division and transferred to New York in early 1952. Later in the year, he was transferred to Albany as operations manager. He was named to his present position in 1954.

in the Industry

THREE PROMOTED AT FOOTE MINERAL COMPANY

W. BROOKING

W. RAYNOR

E. G. ENCK

Ernest G. Enck has been named Director of Planning and William M. Raynor, Director of Purchases, effective May 28, 1956, according to L. G. Bliss, President of Foote Mineral Company, Philadelphia. Walter J. Brooking, formerly General Purchasing Agent, has been promoted to Assistant Director of Purchases.

Enck retains his title of Secretary of the Company but relinquishes his position as Director of Purchases in assuming his new duties. He has been with Foote Mineral since 1926, and has served on the Board of Directors since 1936.

New Director of Purchases

Raynor, who has been with the Company since 1942, served as Manager of Special Products and as Administrative Assistant before receiving his new assignment. He has served in the past on a number of special purchasing assignments involving major sources of supply.

Walter Brooking has been employed in a purchasing capacity with the Company since 1951 and was General Purchasing Agent prior to receiving this latest promotion.

Pure Oil's Langfitt Elected Lehigh Trustee

J. Porter Langfitt, executive vice-president of the Pure Oil Company, Chicago, Ill., was elected to a six-year term as alumnus trustee of Lehigh University at the annual business meeting of the Lehigh Alumni Association this morning on the Lehigh campus.

Langfitt was named to his present position with the Pure Oil Company April 30, 1954.

He was born in Parkersburg, W. Va., and received a bachelor of arts degree from Lehigh in 1924 and a bachelor of science degree in mechanical engineering from Lehigh in 1925. He joined the Pure Oil Company immediately as a laborer at the former Pure refinery at Marcus Hook, Pa. In 1926, he was transferred to Chicago in the refinery department.

Langfitt became assistant to the vice-president in charge of refining in July, 1937, and in April, 1947, was made refining vice-president. He rose to vice-president in charge of research and development in July, 1953.

He is a member of the American Petroleum Institute, a director of the Western Petroleum Refiners Association and a director of the American Society of Testing Materials.

Langfitt was president of the Lehigh Alumni Association from June, 1954, to June, 1955.

Metasap's Licata Speaks On Metallic Soaps

The chemistry of the metallic soaps was the subject of a recent talk by F. J. Licata delivered before the Baskerville Chemical Society of the College of the City of New York.

An authority on the subject, Mr. Licata is Technical Director of the Metasap Chemical Company. He is the author of numerous articles on the metallic soaps and their relation to various industries, and he has contributed a chapter on the subject to the book, "Protective and Decorative Coatings" edited by Matteiello.

Bell, General Mills Founder, Honored by Chemists

J. F. BELL

James Ford Bell, founder and first president of General Mills, Inc., was awarded the first honorary membership ever conferred by the Minnesota Industrial Chemists' Forum for his contributions to industrial chemistry. Currently chairman of the committee on finance and technological progress for General Mills, Mr. Bell was cited for his understanding of the role that science can play in the evolution of business.

Born August 16, 1879, in Philadelphia, young Bell came to Minneapolis with his parents in 1889. His father at that time became actively engaged in the management and consolidation of several small milling companies that ultimately became the Washburn-Crosby Company.

The younger Bell's interest in science and experimentation manifested itself at an early age. Graduated from the University of Minnesota with a Bachelor of Science degree in 1901, he entered upon full-time employment with Washburn-Crosby Co. By 1909 he was a director of the company, and in 1915 elected a vice-president. Not long after, being named president of Washburn-Crosby Co. in 1925, Mr. Bell and his associates set into motion the processes which effected the amalgamation of several corporations into what is today known as General Mills, Inc.

M. W. REYNOLDS

P. C. BUCK

ACHESON ELECTS REYNOLDS AND BUCK TO BOARD

M. W. Reynolds, and P. C. Buck have been elected to the Board of Directors of Acheson Industries, Inc., New York, Howard A. Acheson, President, has announced.

Mr. Reynolds, who has been General Manager of Acheson Colloids Company as well as a Vice-President of Acheson Industries, Inc., will take on new duties as Vice President in charge of Acheson Industries' recently formed International Development Division, with headquarters in the Port Huron offices. He will be assisted by Paul Barnes, formerly Supervisor of Export Sales for Acheson Colloids Company.

John W. Shier has been appointed General Manager, succeeding Mr. Reynolds. Previously, Mr. Shier held the post of Assistant General Manager.

Mr. Buck will continue serving Acheson Industries in his present capacity as Vice President in charge of Production and Engineering, with offices at Port Huron, Michigan.

Acheson Industries, Inc., is the parent organization of Acheson Colloids Company, Port Huron, Michigan, the latter manufacturing colloidal dispersions of graphite, molybdenum disulfide, mica, vermiculite, and zinc oxide, in a wide range of liquid and resin carriers. Associated companies in this country include Acheson Dispersed Pigments Co., of Philadelphia, Pa., producers of ink bases, special purpose inks, and paste and granulated color concentrates for the plastics industry, and Gredag, Inc., Niagara Falls, N. Y., who market graphited and specialty greases. The company's British affiliation is Acheson Colloids Limited, London, manufacturers of the same products at plants in Plymouth and Slough. A new Dutch subsidiary, Acheson Colloiden, N. V. in Scheemda, Holland, will help supply the fast-growing European market.

T. T. CHAPEL

J. S. CROWL

Personnel Appointments at Acheson Colloids

Acheson Colloids Company of Port Huron, Michigan, have announced the appointments of Theron T. Chapel as Product Control Supervisor and James S. Crowl as Supervisor of Process Research. Mr. Crowl is replacing Erwin J. Campbell who now is Product Development Supervisor.

Mr. Chapel graduated from Albion College in 1938, majoring in chemistry and mathematics. After receiving his B.S. degree in Chemical Engineering from the University of Michigan in 1940, he served with the Chemical Warfare Division of the Army during the war. His industrial experience includes adhesive-development research for the Minnesota Mining & Manufacturing Co. and chemical engineering in the Research and Development Division of the Armour Laboratories. A native of Jackson, Michigan, he is a member of the American Chemical Society and the American Society for Quality Control, and takes an active part in civic affairs.

Mr. Crowl, a graduate of Tri-State College in 1947 with a B.S. degree in Chemical Engineering, served as laboratory instructor at the college for several years. He received his M.S. in Chemical Engineering in 1953 from the University of Notre Dame, and since then has been employed by the General American Transportation Corporation for several years. Mr. Crowl is a member of the American Institute of Chemical Engineering and the American Chemical Society.

New Sales Representative Joins NOPCO's Pacific Div.

In line with its expansion of West Coast activities, the Nopco Chemical Company has appointed D. E. Murphy as a new member of its technical sales staff. According to J. B. Connell, Industrial Chemicals Sales Manager of Nopco's Pacific Division, who made the announcement, Mr. Murphy is the fourth technical sales representative added to the staff in the past year.

Mr. Murphy has been assigned to the Southern California sales district, and will make his headquarters in Los Angeles. He has been associated with the chemical industry for many years, in both a technical and sales capacity.

In addition to its plant at Richmond, Calif., Nopco has plants in Harrison and North Arlington, N. J.; Cedartown, Ga.; Los Angeles, Calif.; and London, Ont., Canada. The company is a leading producer of synthetic organic chemicals and industrial processing specialties for a wide variety of industries, including paint and varnish, textile, leather, pulp and paper, plastics, cosmetics, insecticides, metallurgy, and construction materials.

Gulf's Swensrud Speaks at API Spring Meeting

Increasing oil consumption, both within and outside the United States, and finding, developing, and getting to market the needed supplies are pictured as a long-term trend facing the petroleum industry, by S. A. Swensrud, Chairman of the Board of Gulf Oil Corporation.

Mr. Swensrud's talk, in which he described oil as "now the largest of all industries other than agriculture ... and growing rapidly," was given before a meeting of the Eastern District, Division of Production, of the American Petroleum Institute.

He keynoted his broad discussion of future oil demand and supply trends with this forecast:

"It appears probable that we shall find continuing need for moderately increasing quantities of oil from other areas over the near-term future.

"Somewhere along the line, perhaps several decades hence, if and when U. S. productive capacity ceases to expand, or actually begins to decline, we shall then need much greater quantities from other sources to meet the domestic demand."

Industry NEWS

Continental Can and Hazel-Atlas Glass Plan Merger

Plans for merger of the businesses of Continental Can Company, Inc. and Hazel-Atlas Glass Company have been announced by General Lucius D. Clay, Chairman of Continental Can, and John Harrison McNash, Chairman of Hazel-Atlas. The agreement, which will unite an industry leader in the packaging field with a major manufacturer of glass containers, has been approved by directors of each company. It is subject to approval by stockholders of Hazel-Atlas at a special meeting to be called for some time in August.

The terms of the plan provide for shareholders of Hazel-Atlas Glass Company to receive 991,141 shares of Continental Can common stock. This will result in a ratio of 46/100 share of Continental for one share of Hazel-Atlas. On that basis, Continental Can would have a capitalization consisting of $79,648,000 long-term debt, 150,000 shares of $3.75 Cumulative Preferred Stock, and 8,755,499 shares of Common Stock. Hazel-Atlas's present capitalization consists solely of 2,172,045 shares of Common Stock.

At 1955 year-end, Hazel-Atlas had total assets of $37,884,425 and working capital of $19,904,256. Total assets of Continental Can at year-end were $381,917,101 and working capital of $110,815,816.

Step to Broad Diversification

Since Continental has not heretofore been in the glass container business, management of the two companies consider the consolidation a logical step in the development of the company's broad diversification in the packaging field, enabling it to meet practically every packaging requirement of its customers. Continental is an important producer of metal containers and also manufactures fiber drums, paper containers, bottle crowns and caps, flexible packaging materials, plastic containers, paperboard, and other packaging products. The company has 86 manufacturing plants located in 27 states, Canada, and Cuba. 1955 sales totaled $666,266,408 and net income amounted to $3.22 per share adjusted for a 100% stock dividend in 1956. For the first quarter of this year, sales were $155,765,882 and earnings per share were 63c.

Hazel-Atlas Operates 13 Plants

Hazel-Atlas, founded in 1901, is engaged primarily in the manufacture of glass containers for food products, cosmetics, toiletries, beverages and drugs, and of glassware. At the present time, the company operates 13 plants located in Pennsylvania, West Virginia, Ohio, New York, Oklahoma, California, and Alabama. Another plant is under construction in Illinois. In 1955, the company earned $1.86 per share on net sales of $79,919,794. For the three months ended March 31, 1956, sales amounted to $18,281,309 and net earnings were 19c a common share.

Chek-Chart Announces 1956 Lubrication Editions

The Master Lubrication Handbook of The Chek-Chart Corporation of Chicago combines in one new volume all of the information contained in The Corporation's renowned Automotive Lubrication, Truck and Tractor Guides. Such a concentration of material in one loose-leaf book makes The Handbook the most complete reference of its kind. Invaluable as a tool for oil company management and marketing executives, as well as division office personnel, it is relied upon for correct lubrication information approved by the manufacturer.

The 1956 edition, the first section of which has just been published, will contain over 300 pages of lubrication charts and tabular data, including special Service Instructions. Individual sections are devoted to the provision of detailed information for U. S. and European Passenger Car, Truck and Farm Tractor classifications, in addition to a general grouping which comprises School Bus, Motor Coach, Outboard Motor, Motorcycle and Aircraft lubricant recommendations and capacities. Material is revised throughout the year through the medium of The Chek-Chart Service Bulletin.

Revision of Companion Manuals

Revised 1956 editions of the companion manuals "The How and Why of Automotive Lubrication" and "The How and Why of TBA Sales and Service" have been published by The Chek-Chart Corporation of Chicago. Each manual, in its own field, is the most comprehensive available.

"The How and Why of Automobile Lubrication," in its fifth edition, tells not only how to perform automotive lubrication services but also gives the reasons why they are necessary. Line drawings and clearly written text provide stationmen with all information necessary to perform complete body, chassis and under hood services.

The Automatic Transmission section is of particular interest; in its extensively revised and enlarged form, it contributes greatly toward making

Automatic Transmission service, still one of the most difficult problems facing stationmen, a matter of common sense and sound profit.

The fourth edition of "The How and Why of TBA Sales and Service" has also been revised in the light of today's automotive requirements. It explains and illustrates how to inspect a car for TBA needs, install TBA items and propose TBA services. Using the same "how and why" treatment given by the companion lubrication manual, all related groups are covered by individual sections.

Further information may be secured from The Chek-Chart Corporation, Sales Department, 33 East Congress Parkway, Chicago 5.

Archer-Daniels-Midland Expands in Texas

The opening of a new Archer-Daniels-Midland Company sales office at Houston, Texas, May 1, has been announced by James W. Moore, vice president and general sales manager. The office, located at 2525 Cline Street, will be managed by Jack Calkins. John Florence has been assigned as technical sales representative for the Houston area.

The Houston office, serving the Gulf Coast area of Texas, will handle such ADM products as linseed, soybean and marine oils, alkyd resins, fatty acids, chemically modified oils, and Archer Pol-mer-ik Linseed Oil. It also will represent the ADM Chemical Products Division for the following: sperm whale oil, glycerides, fatty alcohols and hydrogenated fatty acids.

Both Calkins and Florence recently completed an intensive eleven week "product familiarization" sales training course conducted by ADM at its Minneapolis, Minnesota research laboratory. The course, consisting of lectures, plant tours, and laboratory work, was designed to give ADM technical salesmen thorough knowledge of the company's many products and their applications.

Calkins, a native of Childress, Texas, joined ADM in January. Previously he spent seven years with the Frontier Chemical Company, division of Union Chemical and Material Corporation, where he worked in production and sales in the capacity as chief chemist and district sales manager. He attended Texas Technological College for two years prior to serving in the U. S. Air Force during World War II. After being discharged he attended Baylor University where he received a Bachelor of Science degree in chemistry in 1949.

Florence came to ADM last fall, following three years' service in the United States Marine Corps as a first lieutenant. Previously he was an assistant account executive with Mays and Company, Los Angeles, California, advertising agency. A native of Los Angeles, Florence attended the University of California at Los Angeles from 1947 to 1951.

Gross Issues Fatty Acids Brochures

A four-page brochure tabulating the specifications and components of Groco fatty acids has just been released by A. Gross & Company, 295 Madison Avenue, New York 17, N. Y., manufacturers of fatty acids for industry since 1837. The brochure permits the reader to see at a glance all vital data on A. Gross stearic, oleic, tallow and vegetable fatty acids. Also included is a list of distributors throughout the country.

Morehouse Mills Announces New Lease Plan

In a move to simplify leasing and credit arrangements for Morehouse Mills and Cowles Dissolvers, Morehouse-Cowles, Inc., of Los Angeles has announced details of two specific plans. According to D. L. Grubbs, General Manager of Morehouse-Cowles, Inc., distributors, the plans are incorporated in two new booklets for use by prospective buyers.

A booklet on the leasing plan, prepared in cooperation with International Leasing Corp., explains a method for procuring use of Morehouse-Cowles equipment without greatly expending working capital. Under the ILC plan the only cash required is one month's rental for each year. Lease is then renewable indefinitely from year to year at sharply reduced rates.

A booklet on credit arrangements describes the Equipment Financing Plan of the Commercial Credit Corporation, and includes details of typical examples. The plan gives great flexibility in permitting the choice of a payment program geared to the user's own methods of calculating depreciation. A 25% down payment initiates the program.

Under either plan, both Morehouse Mills and Cowles Dissolvers may be combined in one contract. Installation and transportation charges may be included, and the full Morehouse-Cowles Purchase Warranty applies.

Morehouse-Cowles, Inc., will continue its policy of demonstration in processors' plants, at the seller's risk and without obligation to buy. The booklets on leasing and credit plans are available without cost from Morehouse-Cowles, Inc., 1150 San Fernando Road, Los Angeles 65, California, or from Morehouse-Cowles representatives in principal cities.

KERR-McGEE PURCHASES CUSHING REFINERY

A transaction closed in New York June 5 gave Kerr-McGee Oil Industries, Inc., ownership of the 20,000-barrel-a-day Cushing, Oklahoma, refinery leased and operated under Kermac management for the past 13 months.

The refinery was sold by General American Oil company, Dallas, which had acquired the property as part of a $27 million deal in July, 1954, in which General American got the major portion of the producing leases, royalties and crude oil pipelines of Deep Rock Oil corporation (now Crescent Corporation).

General American never operated the refinery, but leased it back first to Deep Rock and later, after the Kermac purchase of certain of the assets in April, 1955, to Kerr-McGee.

The purchase gives Kerr-McGee ownership of three refineries with a combined through-put of more than 40,000 barrels of crude oil a day. The other refineries are located at Wynnewood and Cleveland, Oklahoma.

Conclusion of the transaction to purchase the Cushing refinery was viewed by company president Dean A. McGee as "a major step forward for Kerr-McGee Oil Industries, Inc."

NOPCO Honors Veteran Employees

Thirty nine employees of the Nopco Chemical Company who have completed 15 years of service, and 13 who have been with the company 25 years, received awards at a recent party given in their honor by the company. The presentation was made by Ralph Wechsler, President of Nopco, who made a brief welcoming speech.

The 15 year veterans, who automatically become members of the Nopco 15-year club, was the largest group ever to be inducted into the organization at any one time, and brings the membership in that group up to 26.3% of the total Nopco personnel. Of these, 67 have been with the company from 25 to 40 years.

Continental Can Opens $7 Million Research Laboratory in Chicago

Continental Can Company opened a new $7 million laboratory for research and engineering on June 14.

The new Research and Development Center is the largest and most advanced under one roof in the can-making industry, according to T. C. Fogarty, Continental president.

Mr. Fogarty dedicated the laboratory today in ceremonies attended by company officials and employees of the laboratory.

He said that 265 scientists and technicians will work in the newly completed building on problems of new metal containers and non-metal components, new machinery to make and close the containers, and new products suitable for packaging in metal and related materials.

The three-story building was designed to meet the company's expansion needs in metal research and engineering over the next 25 years, Mr. Fogarty said. Located on Chicago's South Side (at 76th St. and Loomis Blvd.), the laboratory includes more than 260,000 square feet of floor space.

"This is our vote of confidence in the future of the metal container," Mr. Fogarty said of the $7 million laboratory. "The can's simple advantages over most other forms of packaging will keep it a strong contender in the current packaging revolution."

Research, he speculated, could double the industry's output of metal containers in five years. (In 1955 some 39 billion metal containers were pro-

duced). He pointed to the tremendous market potential for cans in carbonated soft drinks and fluid whole milk alone, which research has just recently made adaptable for packaging in cans.

Mr. Fogarty predicted that the greatest growth in metal container production over the next decade would come from such products not previously packaged in metal containers. The wide use of cans for frozen citrus fruit juices today, a post-war phenomenon, illustrates the new market possibilities for the can-making industry, Mr. Fogarty said.

$7 Million Research Laboratory

Mr. Fogarty said that Continental, which enjoyed record first-quarter sales for the industry in 1956, has invested $36.7 million in packaging research over the past five years. 60 per cent of this has gone into metal research and engineering.

He added that the company's diversification program of the past five years has made Continental a balanced packaging organization operating in many fields besides metal containers.

Research Is Our Password

"Research is our password to new markets," Mr. Fogarty said. "It has already taken us a long way toward emancipating the can-making industry from its dependence on strategic supplies of tin. Now we are investigating methods of freeing the industry eventually from complete dependence on steel. We are trying out alternate metals with a declining price curve, even though they may still be prohibitively expensive at the present time."

He also mentioned the great market potential of blends of materials, such as steel and plastic, or steel and fibre, in a single container.

"A better container at a lower price is always a major goal of our research efforts," he emphasized.

He said that although changes in metal containers through research are imperceptible to the consumer for the most part, hardly a can on the grocer's shelf today is the same as it was five years ago.

Another major goal of research cited by Mr. Fogarty is more efficient, high speed can-making and can-closing machinery, both of which Continental designs and manufactures. Faster can-making and closing machinery can increase volume and thus help to reduce unit price, which is a critical factor in the relation of the can to its future markets. He mentioned the new Continental 423 HCM can-closing machine, which at 1200 per minute closes cans twice as fast as the rate of a machine gun, as a satisfactory machinery development through research.

Continental's new laboratories are fully equipped to achieve research and engineering goals, Mr. Fogarty said. Notable among its modern precision equipment are a complete can-making pilot plant and a self-contained can-closing line. Conditions in any can-making factory or canning plant can be duplicated.

New Center Serves 41 Plants

The new Metal Research and Development Center will serve Continental's 41 Metal Division plants across the country and 20 field laboratories in the United States, Canada and Cuba. Continental maintains 7 other divisional research and development establishments in the United States and Canada, in addition to the company's Central Research and Engineering facilities, also located in Chicago.

Lenvik Ylvisaker, General Manager of the Metal Division Research and Development Dept. is in charge of the metal research and development program in Chicago.

The building was designed by Schmidt, Garden and Erikson, Chicago architects.

Socony Mobil Acquires Turkish Properties

Concessions covering 2,800,000 acres of land in southern Turkey have been granted by that government to Mobil Overseas Oil Company, an affiliate of Socony Mobil Oil Company, Inc.

Socony Mobil geological investigation was started early in 1953. With the granting of concessions, the company plans to increase the tempo of the exploratory work shortly.

Colloid Symposium Hears Secrets of Colloid Chemistry

Much of the technical advance of industrial colloids over the past half-century has been due to some ingenious theorizing and tireless research on colloidal clay more than 50 years ago.

This basic work by Dr. Edward Goodrich Acheson, whose centennial is currently being celebrated, was outlined in a memorial lecture dedicated to this pioneer of colloid chemistry. The lecture, presented by Dr. H. J. Dawe, (Director of Research and Development, Acheson Colloids Company, Port Huron, Michigan), was delivered at the 30th National Colloid Symposium at Madison, Wisconsin, on June 18.

An abstract of Dr. Dawe's lecture follows:

EDWARD GOODRICH ACHESON: PIONEER IN COLLOID CHEMISTRY

Dr. Edward Goodrich Acheson's attempts to use electric-furnace graphite in the manufacture of crucibles led

to his observation that the well-known widely different characteristics of clays seemed to be related to the nature of the clay bed as opposed to its chemical composition. He postulated that certain sedimentary clays acquired plasticity while suspended in the water from which the bed was deposited. His investigation of the effect of organic extracts on clays revealed that tannin-related materials affected the plasticity and strength of clay bodies. At the same time, the clay became, as he termed it, "deflocculated" in water.

He was able to show that clays could be up-graded by the use of deflocculants. Acheson termed his treatment "Egyptianizing" and the treated clay he called "Egyptianized Clay," in tribute to the early Egyptian Israelites who made clay bricks with the aid of straw. Straw extract was an effective deflocculant. Furthermore, the fact that stable clays are precipitated from suspension by the presence of electrolytes explained satisfactorily, for the first time, the method of formation of river deltas like those of the Nile and the Mississippi.

After Acheson prepared pure electric furnace graphite suitable for lubrication purposes in 1906, it was characteristic of him that he should see how his earlier studies on clay could make the graphite still more useful. He found that graphite could be deflocculated by a large number of natural extracts. The research necessary to produce a commercial product was pursued with vigor, and in 1908 the Acheson Oildag Company was founded to manufacture and sell 'Aquadag' and 'Oildag', the suffix 'dag' being a contraction of "Deflocculated Acheson Graphite."

Curiosity Spurred Ambition

Acheson was a keen observer, quick to realize industrial potential in his discoveries. He pursued an idea relentlessly and made the most of it. Without the advantages of broad academic training, he could undertake the study of as complex a field as clay technology and soon see relationships not apparent to others. It was his unbounded curiosity spurred on by burning ambition, and tempered by a practical appreciation of the potential value of his discoveries, that marked Edward Goodrich Acheson as a practicing scientist of continuing significance.

Southwest Research Road Tests Moly-Sulfide Chassis Grease

Southwest Research Institute, San Antonio, Texas, will conduct a road study for Climax Molybdenum Company evaluating the effect of incorporating Moly-Sulfide additive in chassis grease, it was announced by E. E. Smith, Climax manager of lubricant development.

The program, expected to require twelve months, will consist of road tests to determine the effectiveness of chassis grease in various vehicles under their normal operating conditions. Half the vehicles of each type used in the test will be lubricated with commercial chassis grease, the other half with the same chassis grease in which 3% Moly-Sulfide Pure has been dispersed. Wear will be determined by before-and-after weight comparisons, dimensional measurements and surface inspection of key parts. In the final analysis, these data will be considered in conjunction with service logs and driver reports on squeaks, ease of steering, and other pertinent observations.

Thirty vehicles will travel a total of 1,500,000 to 2,225,000 miles in the road test. Eight city buses, twelve tractor-trailers in long haul service, and ten police cars will be used.

Prior to testing, each vehicle will be inspected to insure that wheel alignment, steering, suspension, drive shaft and brake shoes meet specified standards. In addition, critical parts such as wheel bearings, king pins and bearings, ball joints, brake actuating cams, bushings, shackle pins and bushings, tie rod ends and steering linkage will be replaced with new parts. These will be weighed and measured before installation. During the test, all will be lubricated and inspected at regular mileage intervals. At the conclusion, the parts will be removed, cleaned and again weighed and measured to determine wear.

Drivers of the test vehicles will report daily on such factors as weather conditions, vehicle complaints, road surface conditions, and mechanical breakdowns. Driving procedure for the automobiles and buses will not vary from normal operational practices. However, the tractor-trailers will be routed so that two or more trucks, preferably one with and one without the additives, will travel over the same route.

Archer-Daniels-Midland Announces New Product

ADOL 45, a long chain diol with a high melting point and two OH groups, is now available from the Chemical Products Division of Archer-Daniels-Midland Company, 2191 West 110th Street, Cleveland 2, Ohio.

The new saturated fatty alchohol is a practically odorless, stable, white solid derived from hydrogenated castor oil, melting at 69°C.

This Hydroxy Stearyl alcohol is a new raw material with outstanding potential for compounds such as plastics, resins, solubilizers, stabilizers, emulsifiers, polyesters and surface active agents—detergents, germicides, textile intermediates, cosmetics, waxes and esters.

ADOL 45 is one of many new saturated and unsaturated fatty alcohols being produced at ADM's new plant in Ashtabula, Ohio.

NEW SHELL REFINING PROCESS BOOSTS GAS YIELD

A new oil refining process that helps stretch the nation's fuel supply by getting more gasoline out of crude oil is described by Shell Oil Company.

The development—a two stage catalytic cracker—increases the yield of gasoline from crude oil up to 15 per cent. At the same time, it raises efficiency and thus helps to hold the line against rising costs of refinery operations.

The new process climaxes nearly seven years of intensive research by Shell Oil scientists. It was described in a paper read before the Midyear Meeting of the American Petroleum Institute's Division of Refining at the Sheraton-Mount Royal Hotel here.

The first commercial unit employing the new technique recently came on stream at Shell's brand-new refinery in Anacortes, Washington. It was immediately hailed a success.

Catalytic cracking—"cat cracking" as it is known in the industry—is a process in which a solid material called catalyst is mixed with oil under high temperatures in order to crack big molecules of oil to yield more of the lighter gasoline molecules.

In ordinary catalytic cracking, oil goes through the cracking unit only once. However, in this single passage some of the oil is cracked too much— into molecules too light for gasoline—and some is not cracked enough. The two-stage process prevents overcracking and undercracking and thus produces more gasoline.

In the first stage, according to the Shell paper, hot catalyst strikes oil for a brief period of time, causing it to vaporize and begin to crack. This partially-cracked oil then goes through a separating system which removes gasoline and gas formed in the first stage. The remaining uncracked oil goes on to the second stage reactor.

The second stage is a conventional process employed by standard "cat crackers." It lasts longer than the first stage and is conducted at lower temperatures.

Beside higher gasoline yields, the two-stage cracking system has resulted in lower coke yields and greater flexibility than conventional methods, Shell scientists reported.

The two-stage "cat cracker" at Shell's Anacortes refinery is capable of processing about a million gallons of oil a day.

The new refining system was developed in the Houston research laboratory of Shell Oil Company. First experiments were conducted in small pilot units. Later, a pilot plant unit processing eight barrels of oil a day was used.

Increase of 4% to 5% in Summer Motoring Seen by Tourguide Offices

A 4% to 5% increase in motorists on the road this summer, as compared to last year, is foreseen by one organization to which motorists tell their plans—the Tourgide Bureau of Gulf Oil Corporation.

The estimate is based on inquiries received in eight major cities in the eastern half of the country (and Texas) where the Bureau supplies free travel information to motorists. It is considered conservative by the staff, which has been increased from 29 to 63 persons to handle summer volume.

They report inquiries for motor trip information from their major source—namely, request postcards secured by drivers at service stations—are running an average of 8% above last year throughout the system. Inquiries coming in by phone and over the counter are up 4% to 6% and still rising.

To show how seriously they are considering the increasing inquiries, the organization is printing 2,000,000 new request cards, and getting set to distribute 11,000,000 to 12,000,000 road maps.

Even at this staggering volume, less maps per motorist will be distributed than in some prior years because of a trend to regional maps (spanning a number of states) and because motorists are becoming "map conservation" minded.

What's new in motoring plans confided to the Bureau?

The biggest trend (new in the sense that it will substantially increase in volume) is the number of vacationists east of the Mississippi who will drive southward. The trek there this summer promises to be the biggest in history.

"The old concept of Southern states solely as Winter resorts will be wiped completely off the slate by this summer's vacationing motorist," said one Bureau official. "The automobile is giving the South a year-round season and the majority of motorists appear to have Florida marked as their destination."

New England also appears slated for the heaviest vacation travel in its experience, although behind Florida and other Southern areas.

Motorists in the eastern half of the U.S. are continuing to reduce the number of long western trips, which were popular for a number of years after World War II.

Besides the once-a-year vacation, the inquiries show this summer will

see more week-end driving than ever. A major factor will be improvement of present state parks, and the opening of new ones, giving the city-dweller economical outdoor recreation within week-end range.

One long-term trend in the survey is that motorists are more interested in reaching their destination rapidly than in the beauties of the trip. While a substantial number still fill in the request card space asking for the "scenic" route, these folks are dwindling compared with those wanting the "quickest" express road.

What information do motorists chiefly ask for? Answer: maps with their route marked from start to destination. The very increase in number and quality of roads has made informed advice on "the best way to get there" increasingly important.

The bureau found one happy difference from earlier days in the near disappearance of motor trip problems caused by long, bumper-to-bumper, back-road detours. Modern alternate routes largely enable by-passing such nuisances. This situation is almost enough in itself to account for the coming motoring heyday!

U. S. Steel's Blough Discusses Specialized Manpower Shortage

The present shortage of engineers and scientists in the United States is due primarily to the unprecedented growth of our economy rather than the threats imposed by Russian advances in technology, Roger M. Blough, chairman of the board of United States Steel Corporation, said.

The U. S. Steel chairman said the shortage of engineers and scientists should not be regarded as an isolated problem, but as "symptomatic of a growing shortage of adequate manpower in other fields of endeavor in the United States.

"It is rapidly becoming harder to single out one area of our industrial world or one form of human endeavor where the manpower need is greatest," Mr. Blough declared. "Looking ahead, say 25 years, the supply of skilled manpower seems to become less and less adequate. Yet it is certainly clear that the rapidity and the character of our progress depends on well trained, highly-principled manpower."

The United States is now moving toward solution of the shortage in engineering and scientific manpower "within the tested American process of responsible persons doing their own thinking and acting in a competitive economy," Mr. Blough said. He listed three ways in which America is acting to produce "as many engineers as we need, not only for our national protection, but above all for our national growth."

Most large companies, including U. S. Steel, are moving forward with programs to insure the fullest and most satisfying use of their engineering and scientific personnel, he continued. He cited the widening use of electronic machines to relieve engineers of routine work, and the institution by many companies of study courses in professional advancement for engineers and in training employees to become technicians and assistants to engineers.

The chief executive officer of U. S. Steel placed heaviest emphasis on the appeal to young people of the honor, prestige, and sense of service in engineering and scientific careers. Mr. Blough expressed confidence that this appeal would attract young people who like the challenge of rigorous preparation for professions that are not only financially rewarding, but rewarding to the spirit as well.

In warning against the folly of discounting "the capabilities of tyranny and dictatorship for conquest and destruction," Mr. Blough pointed out that in 1954 the Soviet Union graduated 53,000 engineers, compared to 20,000 in the United States that same year, which was an unusually low one. He also cited Russia's increase in steel production from 20 million tons in 1940 to 50 million last year. Although the steel companies of the United States produced more than twice that amount—an unprecedented 117 million tons in 1955—the Soviet record indicates that Russian steel-making capacity and production methods are improving rapidly, Mr. Blough said.

"But these comparisons do not imply that the United States, with its economy of private ownership and operation, is falling behind Russia, with its government-controlled and directed economy," Mr. Blough declared. "I am not willing to endorse any such inference."

Compatibility Testing of Lubricating Greases

ASTM's Technical Committee "G" Prepared the Following Statement

"Compatibility of lubricating greases implies compatibility in service. Owing to the complexity of service problems, there is no single test which can be used to satisfactorily evaluate compatibility in general.

"Present ASTM methods, such as those for Dropping Point, Worked Penetration, and Leakage Tendencies of Automotive Wheel Bearing Greases, may be used to test mixtures of greases as well as to test individual greases. Results obtained on such mixtures, as compared to results on the unmixed component greases, are indicative of the compatability of the mixtures. However, simple bench tests such as these must be correlated with a particular set of service conditions before a valid estimate of compatibility in such service can be achieved."

KYODO GREASE TIMES QUOTES HEMMINGWAY

The March issue of the Kyodo Grease Times published by our Japanese member, Kyodo Yushi Co., Ltd., summarized past president H. L. Hemmingway's 23rd annual meeting address (at the right).

申上げました通り耐水性を示す語として、"Wash Out" と "Wash Off" とがあります。両者は同一の試験法があります。これは、Water Washing Out Test と Water Absorption Test があり、その一つ(Water Washing Out Test) は ASTM D 1264-53 T ; Water Wash out Characteristics of Lubricating Greases. 及び Federal Specification VV-L-791 e ; Method 3252.1, Water Resistance of Lubricating Greases で行はれます。この方法はアンチフリクションベアリングに試験グリースをつめ試験を組みこのハウジングの外側に一定の量の水をノヅルから打ち

Olii Minerali Reprints Spokesman Article

Our industry's Italian publication reprinted "Correlation of Bench Tests of Lubricating Grease with Service Tests in Wheel Bearings" by Boner, Hale and Williams of Battenfeld.

Correlazione tra le prove al banco di grassi lubrificanti con le prove pratiche nei supporti per assi

C. J. Boner, H. E. Hale e G. A. Williams: «*NLGI Spok.*» - 19, n. 10, pag. 10 (gennaio 1956).

Tre grassi lubrificanti, uno a base di bario e due a base di litio, sono stati sottoposti a prove al banco e a prove di funzionamento pratico, per vedere se c'era relazione tra i due tipi di prove. Per le prove al banco sono state impiegate le Wheel Bearing Test Machines; per le prove pratiche sono stati eseguiti percorsi di 20.000 e di 50.000 mi-

FAMILIAR material reproduced in overseas editions—Japanese (above) and Italian, shows interest abroad in NLGI technical articles.

An increase in the life of chassis lubricants is needed, most lubricant experts agree. If the on-the-job testing now under way bears out the promising results that Moly-Sulfide greases have given thus far, they would appear to be the most economical solution to the problems of chassis lubrication.

Moly-Sulfide, it is explained in the bulletin, functions by depositing out of the grease in a thin film that adheres tenaciously to the steel in the part being lubricated. When the grease is washed or wiped out of the bearing under normal or abnormal driving conditions, this film of Moly-Sulfide is present as "the second line of defense" to keep the bearing surfaces lubricated until the grease film is restored. This prevents galling, welding and fretting of parts, reducing wear and resulting in a smooth, quiet ride between servicings.

Climax does not add Moly-Sulfide to grease. It merely supplies Moly-Sulfide additive to oil and grease manufacturers.

Climax Offers Bulletin on Moly-Sulfide in Chassis Grease

Moly-Sulfide in Chassis Greases, an 8-page bulletin explaining how the lubricant additive Moly-Sulfide functions in chassis grease and detailing its properties and current technological status, has just been issued by Climax Molybdenum Company, Dept. L, 500 Fifth Avenue, New York 36, N. Y. Designated Bulletin Lu-8a, it is available from the company on request.

The booklet reveals that extensive fleet tests on package-delivery trucks, long-distance trucks and trailers, buses, police cars and utility maintenance trucks are now in progress to check the performance of chassis greases containing Moly-Sulfide under actual road conditions. These controlled tests have been undertaken because laboratory and field experiences indicate that the addition of a 3% Moly-Sulfide of a fine particle size to chassis grease reduces wear on critical points and extends the lubrication period.

FUTURE MEETINGS of the Industry

JULY, 1956

10-12 API Committee on Agriculture (Summer business meeting and annual field trip), College of Agriculture, Cornell University, Ithaca, N. Y.

18-21 Silver Bay Conference on Human Relations in Industry, Silver Bay, N. Y.

AUGUST, 1956

16 API OIIC Steering Committee, API Board Room, New York City

19-24 National Congress of Petroleum Retailers, Inc. (10th annual session), Shoreham Hotel, Washington, D. C.

SEPTEMBER, 1956

6-7 API Oil Industry Information Committee, Conrad Hilton Hotel, Chicago.

7 Midwest Research Institute Symposium on Industrial Development, Linda Hall Library, Kansas City, Mo.

7-8 Desk & Derrick Club, New Orleans, La.

12-14 National Petroleum Association (annual meeting), Traymore Hotel, Atlantic City, N. J.

13-14 Petroleum Packaging Committee, Palmer House, Chicago, Illinois.

16-18 New Mexico Petroleum Industries Committee (annual convention), Hilton Hotel, Albuquerque.

16-21 American Chemical Society (130th annual meeting), Atlantic City, N. J.

16-22 ASTM 2nd Pacific Area National Meeting and Apparatus Exhibit, Hotel Statler, Los Angeles, Calif.

19-21 National Industrial Conference Board (marketing meeting) Waldorf-Astoria Hotel, New York, N. Y.

20-21 Western Petroleum Refiners Association (technical industrial relations meeting), Henning Hotel, Casper, Wyo.

20-21 Mid-Continent Oil & Gas Assn. (membership meeting La.-Ark. Division), Roosevelt Hotel, New Orleans, La.

24-25 IOCA Ninth Annual Meeting, Bismarck Hotel, Chicago, Ill.

OCTOBER, 1956

1-3 Texas Mid-Continent Oil & Gas Association (annual meeting), Rice Hotel, Houston, Texas.

2-3 Texas Mid-Continent Oil and Gas Association (37th annual meeting), Rice Hotel, Houston.

2-4 National Association of Corrosion Engineers (South central region), Beaumont, Texas.

2-6 Society of Automotive Engineers, Inc. (national aeronautic meeting, aircraft engrg. display), Statler Hotel, Los Angeles.

3 American Iron and Steel Institute (regional technical meeting), Thomas Jefferson Hotel, Birmingham.

1-5 American Institute of Electrical Engrs. (1956 Fall general), Morrison Hotel, Chicago, Ill.

7-9 American Association of Oilwell Drilling Contractors (annual meeting), Texas Hotel, Fort Worth.

8-10 The American Society of Mechanical Engineers (joint ASME-ASLE lubrication conference), Chalfonte - Haddon Hall, Atlantic City.

11-12 California Natural Gasoline Association (fall meeting), Sheraton Hintington Hotel, Pasadena, Cal.

14-20 American Petroleum Institute Oil Progress Week.

15-17 American Institute of Mining, Metallurgical, and Petroleum Engineers, Petroleum Branch, Biltmore Hotel, Los Angeles.

15-19 American Society of Civil Engineers (annual convention), William Penn Hotel, Pittsburgh, Pa.

17-19 National Industrial Conference Board (atomic energy meeting), Waldorf-Astoria Hotel, New York, N. Y.

18-19 Western Petroleum Refiners Association (technical industrial relations meeting), Rufus Garrett Hotel, El Dorado, Ark.

22-24 NLGI ANNUAL MEETING, Edgewater Beach Hotel, Chicago, Ill.

22-24 American Standards Association (7th national conference on standards), Roosevelt Hotel, New York City.

22-24 Rocky Mountain Oil and Gas Association (annual convention), Cosmopolitan Hotel, Denver.

23 American Society of Safety Engineers (annual meeting), Conrad Hilton Hotel, Chicago.

29-30 Independent Petroleum Association of America (annual meeting) Statler Hotel, Dallas, Texas.

NOVEMBER, 1956

1-2 SAE National Diesel Engine Meeting, Drake Hotel, Chicago.

8-9 SAE National Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.

8-10 National Oil Jobbers Council (annual meeting), Palmer House, Chicago.

12 API OIIC Steering Committee, Conrad Hilton Hotel, Chicago.

12-15 American Petroleum Institute (36th annual meeting), Conrad Hilton & Palmer House, Chicago, Ill.

26-30 National Exposition of Power and Mechanical Engineering (ASME), New Coliseum, New York, N. Y.

27-30 American Chemical Society (9th National Chemical Exposition), Cleveland, Ohio.

DECEMBER, 1956

4-5 Petroleum Packaging Committee, Savannah, Georgia.

APRIL, 1957

16-18 National Petroleum Association, Cleveland, Ohio

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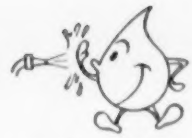

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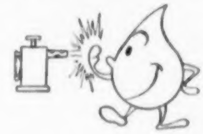
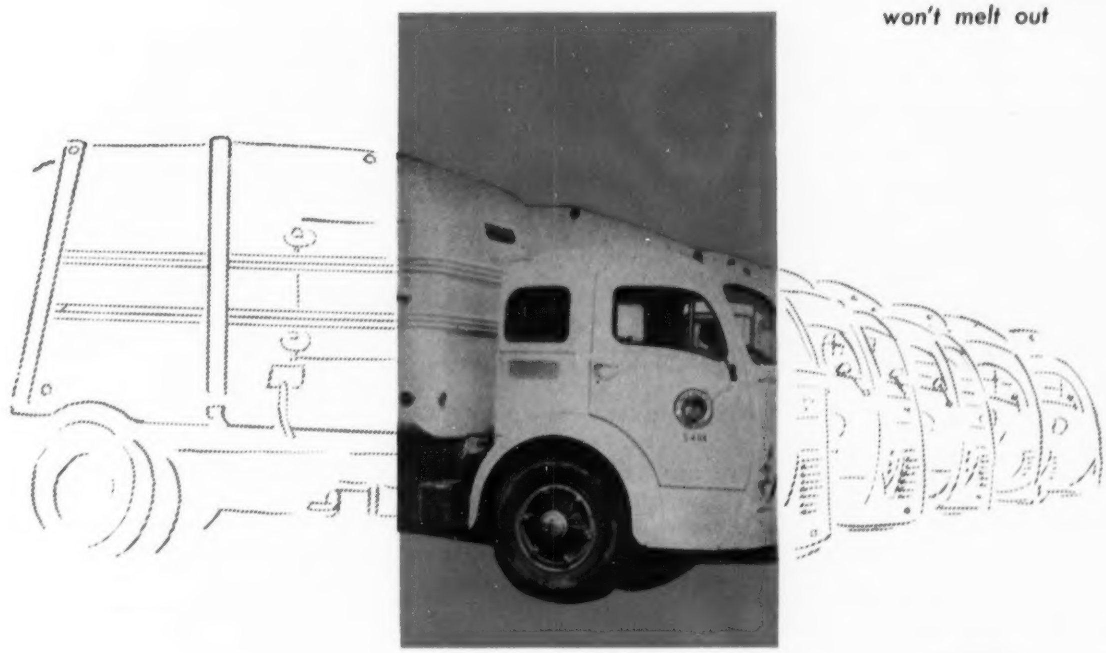


won't melt out



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With Research Comes Quality, With Quality Comes Leadership

Quite a few orders have been received already . . . the NLGI produced movie — "Grease, the Magic Film"—has attracted attention in the lubricating grease industry and commitments to purchase prints for early 1957 have been coming in to the Institute offices. Members and friends of NLGI were given the opportunity last month to order copies of a 16 mm sound movie in color, depicting grease from early times right up to today's need for lubricating greases in almost every phase of our complex economy.

Illustrated in cartoon style and designed to appeal to a vast number of audiences, "The Magic Film" will be produced as a merchandising, educational and public relations piece for members of the industry who desire to put it to work. Running time is approximately 25 minutes for a movie which will be at once entertaining and enlightening. Estimated cost of the film is $30,000 and individual prints are $800 each, subject to a substantial quantity discount when more than one film is purchased by a company.

Yes, We Have Them

Many SPOKESMAN readers have been asking whether they can still order NLGI's wheel bearing manual in large quantities. The answer is *yes*. The manual, "Recommended Practices for Lubricating Automotive Front Wheel Bearings," is the most complete, but concise service we know of for this important phase of lubrication. Over 90,000 readers think so too, and we've just replenished our supply in order to continue filling your orders. The manuals are priced at 15 cents per copy or $9.50 per hundred.

Hit the Top

Several compliments have been received on the June issue of the SPOKESMAN . . . the handsome appearance of this magazine was made possible by the highest total of paid advertising in the journal's history. More color too, as advertisers brighten their messages to SPOKESMAN's select audience.

The magazine has pulling power, as witness the many replies to a classified advertisement. Inquiries were received from all over the country.

Rooms at a Premium

The NLGI Annual Meeting, the Institute's 24th, will be held in Chicago next October, at the Edgewater Beach hotel. October 22-24 are the dates scheduled for the event, and reservation cards for rooms at the Edgewater were mailed to members and friends last month.

Special consideration should be given to obtaining rooms for the Annual Meeting as quickly as possible, for the reservations are difficult to get later on, in the fall. A number of interesting talks have been included on the program.

SERVICE AIDS OFFERED BY NLGI

- **NLGI SPOKESMAN — Bound Volume XIX, covering past issues from April, 1955 through March, 1956. An excellent reference source, sturdily bound in a handsome green cover. $6.00 each, plus postage.**

- **NLGI SPOKESMAN — Bound Volumes XVI, XVII, and XVIII, a few copies of each to fill out your SPOKESMAN set. $6.00 each, plus postage.**

- **WHEEL BEARING MANUAL—"Recommended Practices for Lubricating Automotive Front Wheel Bearings." More than 90,000 copies of this booklet have been distributed throughout the world. Just fifteen cents a copy with quantity discounts—company imprint can be arranged.**

- **BONER'S BOOK — Manufacture and Application of Lubricating Greases, by C. J. Boner. This giant, 982-page book with 23 chapters dealing with every phase of lubricating greases is a must for everyone who uses, manufactures or sells grease lubricants. A great deal of practical value. $18.50.**

- **NLGI FILM — Grease, the Magic Film, a 16-mm sound movie in color running about 25 minutes, to be released early in 1957 (see above). Institute sponsored at a cost of $30,000, individual prints may be ordered now for $800.**

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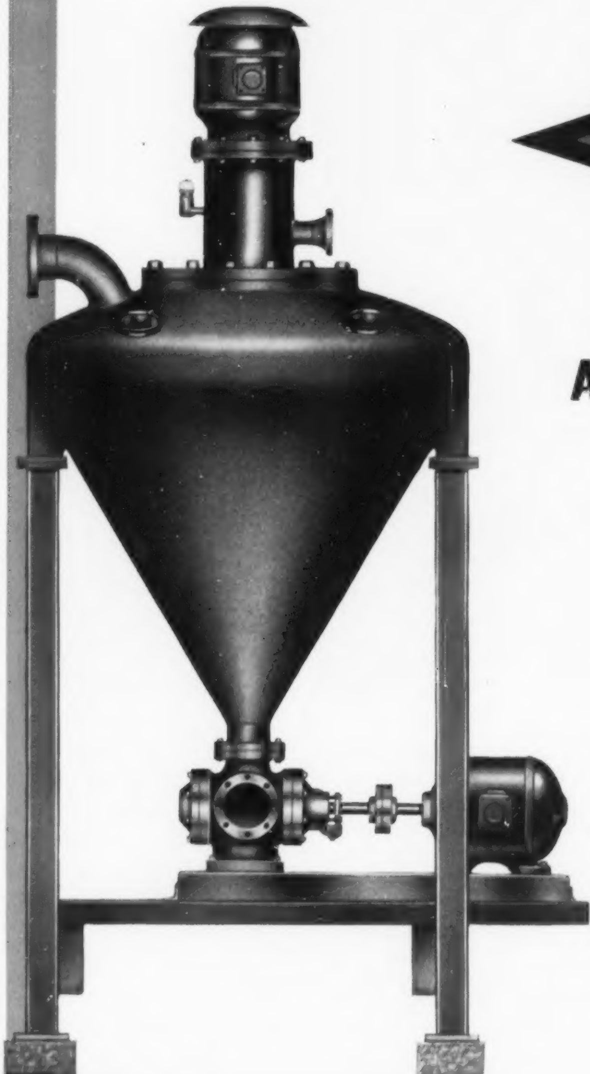

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